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MODERN BURNER EQUIPMENT FOR GLASS WORKING

The Principles of Working or Reforming Glass Articles and How They Are Applied to Burner Design When Changing From Manufactured to Mixed or Full Natural Gas.

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To the man using gas to shape and fabricate glass on a commercial scale, especially with high speed lamp making machinery, gas is not just gas. Each kind of gas burns just enough differently so that special burners and skill may be required for economical utilization. When a change is made from manufactured gas to natural gas, or to a mixed gas, the one most seriously affected and the one that complains the most is usually a glass working unit.

In the manufacture of glass there are three steps: (1) The melting of the glass batch and the fining of the same to eliminate bubbles (seeds) and cords. (2) The forming of the fined glass into articles of commerce by pressing; press and blow; blowing bulbs by machine of which the high-speed Corning ribbon machine is the prime example; and the drawing of tubing by Danner or Vello machines. (3) The reworking of the formed products, such as bulbs and tubing, into finished products such as electric lamps, both incandescent and fluorescent; small switches, both mercury and electronic starters, for fluorescent bulbs; and neon signs, including lamp manufacture, assembly and installation.

The size of the factories doing this work ranges from the infinitesimal, i.e. a small neon sign shop with one or two employed making a few lamps per day, to almost the infinite where a single factory unit of one of the large electrical concerns employs 3,000 or more help and ships daily over 800,000 finished household lamps. These varied factories are the glass working units whose problems are discussed in this article, when changes of the gas for burner work is made from the manufactured variety to natural gas or to mixtures of natural gas.

This glass working industry points up the use of the finest control of combustion of any industry and its gas burners for the assembly of the glass parts require the closest attention to the scientific and technical principles of any gas-using industry. The burners herein described can be and are used for the working of all kinds of glasses and quartz.

In all high-speed lamp factories, the shape and temperature of the gas flame is of prime importance. When heated, glass progressively softens and, scientifically speaking, its working range is usually between the viscosity values of Log 3 and Log 5 (Poises). This corresponds to a change in viscosity in the working range or a change in the stiffness of 100 times and means a temperature change of 500° F. during which the viscosity doubles every 10° F. This indicates how sensitive a piece of glass is to the application of heat.

The temperature-viscosity points for characteristic glass working operations for several kinds of glasses are shown on Fig. 1. The use of this curve enables one to forecast the probable operating temperatures of a new glass when the viscosity-temperature relationship of the glass is known. Comparison of these figures and those of the glass in regular use will furnish a very valuable lead as to proper working temperatures on a given machine.

The operations involved in the assembly of the common incandescent lamp shown in Fig. 2 serve to indicate the temperature of operation for similar glass working operations. The viscosity temperature relationships are shown in Table 1.

The problem of working glass is to apply a definite amount of heat, at the right temperature at the right place, all at the right time to assure low operating losses. Several relationships are involved in these applications, but we will confine our remarks to those encountered in the use of natural, manufactured and

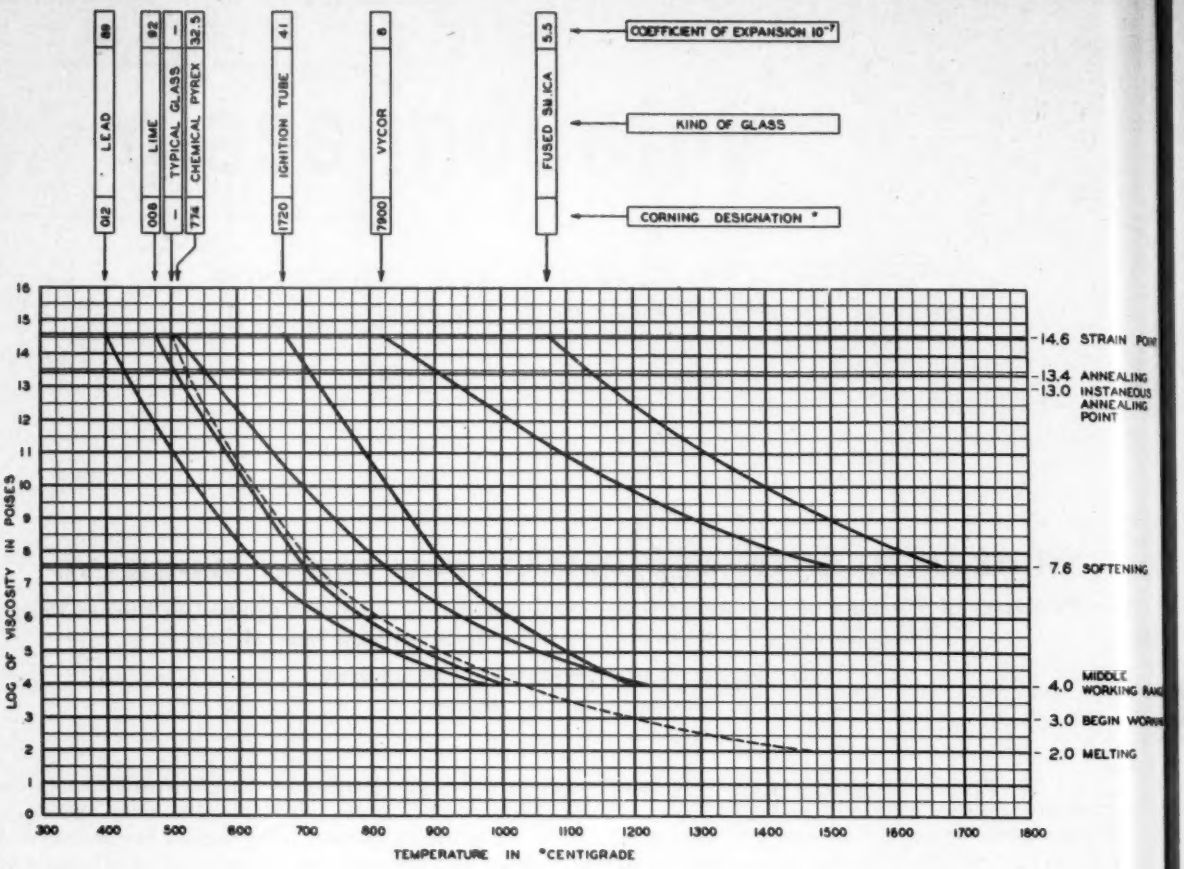


FIG. 1 VISCOSITY-TEMPERATURE RELATIONSHIP FOR VARIOUS GLASSES

TABLE I

Operation on Glass	*Factory Operation*	*Glass Type*	*Approx. Temp. °C.*	*Viscosity Log*
1. Shaping	Flare making	Lead	800	5.5
2. Sealing glass to metal	Stem making	Lead	1000	3.8
3. Sealing glass to glass	Sealing-in	Lime to lead	1050	3.5
4. Cutting off excess glass	Cullet cut-off	Lime	1140	3.3
	Tipping Exhaust Tube	Lead	1100	3.3

mixed gases for the glass working burners, all in the open.

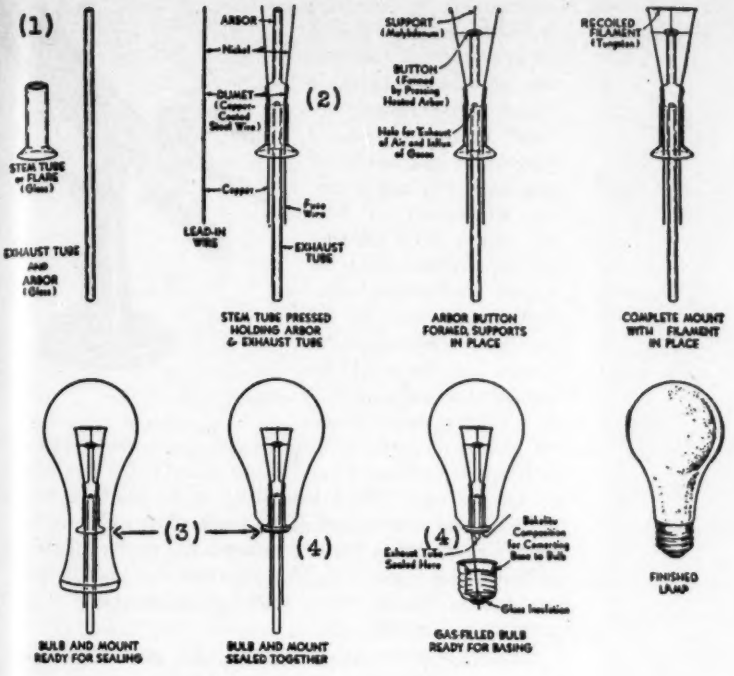
Gas Flame Characteristics

Figure 3 pictures the various parts of a flame and burner.

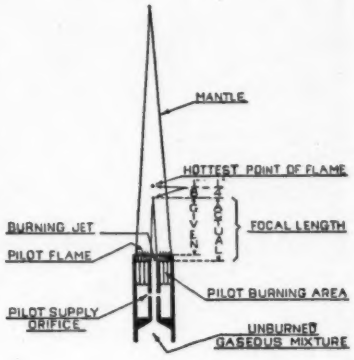
The burning characteristics of gases which are affected by composition, their scientific basis and the effect they have on burner design and operation are: (1) *Flame Shape—Focal Length*: The relation of the burner to the work is fixed by the design of the machine. Consequently, this requires that the right amount of heat be applied to the right spot. This means that the focal length of the flame is definitely expected to be fixed. (2) *Flame Temperature*: This is desired to be as high as possible at the point of application. (3) *Flame Character*—i.e. Oxidizing or Reducing: Lead glass blackens with a reducing (gas rich) flame and alumina glasses cloud up with an oxidizing (air rich) flame. (4) *Heat Release*: The time of working in some operations is three seconds, rarely more than 30 seconds, so the B.T.U. release per minute is an important item in the use of the gas.

These factors are influenced by two characteristics of the gases and their air mixture. (The usual air-gas ratios of the burning mixtures used for glass working range from three to five parts of air to one of gas for manufactured gas, and from eight to thirteen parts of air to one of gas for natural gas.) (1) *Rate of flame propagation or ignition velocity*. In this work the ignition velocity of a free flame is used. This is plotted for the range of useful air-gas ratios in Figure 4. (2) *Flame temperature of the gas-air mixtures*. Figure 5 shows the variation of the flame temperature of natural and carburetted water gas over the usually used air-gas ratios. These measurements are comparable since they were made by the same observers.

In the conversion of manufactured gas to natural gas, the above factors of flame propagation and temperature have a marked effect on three things: (a) Actual burner designs, particularly pilotage. (b) Heat release for definite areas of ports (a factor in actual burner design, but so important as to be noted separately). (c) Opera-



Left: Fig. 2. Steps in assembling mount and completed lamp. 1) Shaping. 2) Glass-Metal Seal. 3) Glass-Glass Seal. 4) Cutting Off Excess Glass. Below: Figure 3.



tor's handling of the burner adjustments to be made.

Burner Design

All burners used in the most sensitive parts of lamp glass working equipment are piloted burners. Such a burner is shown diagrammatically in Fig. 3.

Pilotage or Pilot Ratio for Different Gases. Due to the slower flame propagation of natural gas (Figure 4), it is necessary to have a larger per cent of pilot flame and a larger pilot burning area to burn this gas than for manufactured gas. This relationship is shown in Table 2. This indicates that in any complete conversion to natural gas, a general revamping of the burners is needed. Some of the details of these changes will be given later.

TABLE 2
PILOTAGE

GAS	Max. Flame Speed Ft. per Second	% Pilot Jet Range	Ratio Average	Area Pilot Burning Area Area Ports Range (Times)
Hydrogen	9.2	No pilots		No pilots
Manufactured	2.2	10-40	25	8-12
Natural	1.0	50-200	90	20-30

TABLE 3
HEAT RELEASE—B.T.U. PER HOUR PER SQ. IN. OF JET AREA—INCLUDING PILOT AREA
(Except as noted figures are for perfect combustion flames)

	AIR—GAS			OXYGEN—GAS	
	Drilled Pipe Without Pilots	With Pilots		Without Pilots	With Pilots
GAS	Usual Household Operation—55% Air	Extreme 70% Air	Glass Working Burners	Glass Working Burners	
Manufactured	30,000	19,000	500,000	800,000 to 1,200,000	1,500,000
Natural	18,000	9,500	300,000	800,000 to 1,200,000	1,850,000

Heat Release of Ports as Affected by Different Gases. The practical effect of this factor is seen from Table 3 where the heat release in B.T.U. of natural gas at the usual air-gas ratios is about 60 per cent of that of manufactured gas.

When these two factors are applied to burner design, we come up against the fact that the machine construction is fixed and made for a definite flame length. Since in practice the slower flame propagation of the natural gas places the working point of the flame out further from the burner tip, trouble arises. The effect of the two gases on focal length is given in Table 4.

Thus, it is necessary to reconcile the following factors: B.T.U. release per port area, focal length, and the effective flame temperature at the point of use. To get the heat release needed, approximately 60 per cent more port area is required with natural gas than with manu-

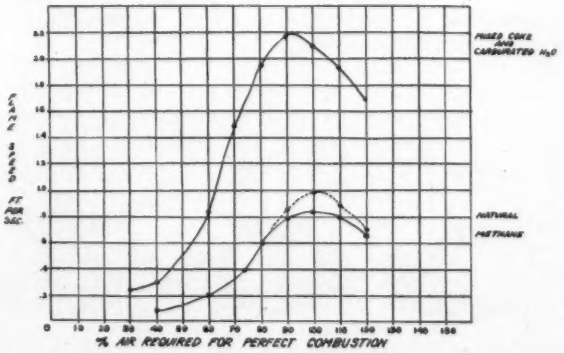


Fig. 4. Rate of flame propagation of gases at various gas ratios.

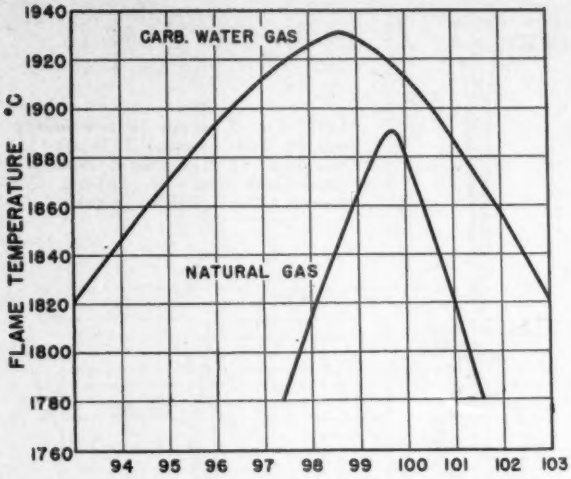


Figure 5. Flame temperature of various gas-air mixtures in the range used for glass working burners.

TABLE 4

Burner Jet Drill Size No.	*Approx. Focal Length in Inches*	
	Mfg. Gas	*Nat. Gas*
55-56	2½	3¾
62	1½	2¼
71	½	¾

factured gas. This means longer flames with the same port diameter so more ports of smaller diameter are called for.

Also, the pilot burning area must be increased to about double with natural gas. Thus, a burner of dimensions too large for its place on the machine may be the result and a small burner compromising the port area, the per cent pilot supply and the pilot burning area must be worked out. The result while usable is rarely perfectly satisfactory.

The difference in appearance of natural gas and manufactured gas burners of the same capacity is seen from the examples in Figure 6.

Operator's Handling of Burner Adjustments

The ordinary firesetter on a glass working machine using manufactured gas which is changed over to natural gas has several technical factors to face which require a change in his thinking since all the adjustments require more careful handling.

Reference to the curve in Figure 5 shows that if an operator, for instance, was accustomed to use a flame temperature of 1860° C. and above for a job using manufactured gas, he could use a gas-air adjustment of 94.7 per cent to 101.8 per cent of the air-gas ratio required for perfect combustion, whereas to get the same temperature in natural gas, he would be limited to a range of 98.9 to 100.3 per cent. When the change is made to natural gas, the range of his adjustment is reduced from 7.1 per cent (101.8 less 94.7) to 1.4 per cent (100.3 less 98.9) so he must be much more careful and skilled in his work when using natural gas. This range is further reduced if a reducing or an oxidizing fire is needed. This situation is a very disturbing one on the operator's thinking and requires a new outlook on the job.

Figure 7.

To complicate matters further, the maximum flame temperature obtainable with the natural gas and air is approximately 40°C. (72°F.) cooler than with manufactured gas and air. It has been found that on the same operation the use of natural gas when burned with air requires about 10 per cent more B.T.U. to do the job than is required with manufactured gas.

To burn an equal number of B.T.U. of natural gas requires more air or oxygen than manufactured gas. This is seen from the following calculation:

	B.T.U./FT³		NET BTU PERFECT COMBUSTION Per on cubic foot of	
	Gross	*Net*	*Oxygen*	*Air*
Carburetted Water gas	528	481	506	106.5
Natural Gas ..... (93% Methane)	1040	936	442	93

Thus the natural gas requires 14.5 per cent more oxygen or air to give the same effective (Net) B.T.U. as the usual manufactured gas. This does not mean that 14.5 per cent more oxygen is needed to do the same job when natural gas and oxygen are substituted for manu-

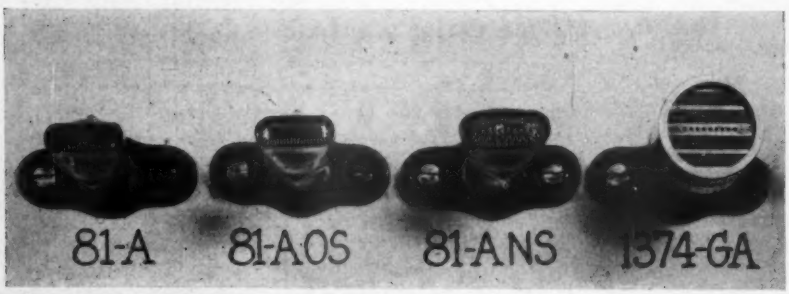


Fig. 6. The burner heads show required increase in pilotage area modified for use on 98 per cent methane. Left to right: 81-A for manufactured gas; 81-AOS for propane and mixed gases; 81-ANS for natural gas; and 1374-GA for natural gas of high methane content. When tested on 98 per cent methane, the burner head pressure before blow-off is: 81-A, about ¼"; 81-AOS, about 1"; 81-ANS, about 10"; 1374-GA, more than 10". Approximate usable consumption of 98 methane, cu. ft./hr.: 81-A, none; 81-AOS, extremely small; 81-ANS, 3½; 1374-GA, 5.0. (Burner heads, American Gas Furnace Co.)

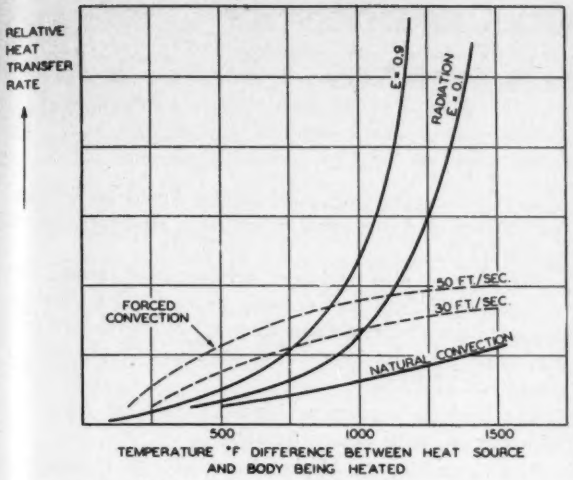


Figure 8.

factured gas and oxygen. The higher temperature of the natural gas-oxygen flame as noted above makes for faster transmission of heat to the glass being worked and results in somewhat less B.T.U. being used to do the job in the same time. This is a difficult factor to evaluate accurately, but usual experience indicates that when a job requiring the use of oxygen is changed from manufactured gas to natural gas, the oxygen consumption may be little changed, but the B.T.U. used is slightly less. Apparently the higher flame temperature of the oxygen-natural gas flame makes the B.T.U. of natural gas more effective.

Hand Working Burners

Many small shops are but glorified glass blower benches and use burners that are suitable for hand work where skill in operation rather than accuracy of timing is the prime requisite. Since the time factor is under control of the operator, not the machine as in a production line, less sensitive burners can be and are used.

The most popular is a nozzle mixing torch or blast burner. This comes in a variety of sizes and is illustrated by Fig. 7. Where this burner is used for work requiring oxygen, there is little or no trouble when changing gas. However, when only gas and air are required, trouble immediately arises when a manufactured gas burner is used on natural gas. A modified means of mixing is used for the natural gas and air. A perforated grid with small holes is provided for the gas outlet so that gas issues at lower velocity and can mix well with the air. A set back is provided to help flame retention.

Care should be taken to be sure that a blast burner be guaranteed to operate on high methane content natural gas.

Ceramic Burners

It is becoming increasingly popular to use ceramic cup type burners in the open to anneal glass parts after reworking. In this, they frequently replace drilled port or other type of enclosed ovens. Due to the high temperature of the radiant source (around 2000°F.) and the almost instantaneous penetration of glass by radiant rays, a piece of glass will be the same temperature on both sides even if exposed to the burner on one side only. Fig. 8 illustrates the data showing the basic facts in this operation.

Fig. 9. Annealing of double glass metal seal after manual operation. Annealing takes place while operator works on next piece.

An example of the use of this method is shown in Fig. 9 where a double glass metal seal is annealed after assembly while the next unit is being assembled.

These open burners require different contours and tips for natural and manufactured gases. This is evident from Fig. 10. However, when a smaller burner is used, this can be of universal use, burning satisfactorily on all gases, Fig. 11.

Miscellaneous Factors of Gas Supply

As noted before, in high speed equipment the time of application of the gas flame to the work is of very short duration. This means close pressure control of the gas supply at the machine, and is more important with natural than manufactured gas.

Specific gravity variation of the gas is also a cause of trouble. A change of specific gravity of .03 (i.e. from .62 to .65) will require the resetting of all gas valves on the glass working machine to avoid objectionable shrinkage, which means spoilage. Thus natural gas mixed from several sources and delivered during the factory working hours will be the subject of complaints. Where specific gravity variation on the direct gas send-

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G.C.M.I. HOLDS ANNUAL MEETING AT WHITE SULPHUR SPRINGS

Lewis F. Gayner, Executive Vice President of the Gayner Glass Works, was re-elected President of the Glass Container Manufacturers Institute at that organization's Annual Meeting, held May 22-24 in the Greenbrier Hotel, White Sulphur Springs, W. Va. The First Vice President, J. C. Feagley, Vice President and General Manager of the Glass Container Division of the Armstrong Cork Company, and the Second Vice President, Harold F. Merritt, Vice President of Solvay Sales Corp., also were renamed to their respective posts.

Two new trustees were elected in the balloting: C. R. Avery of the Chattanooga Glass Company and J. M. Foster of the Foster-Forbes Glass Company, Marion, Ind. They replace I. R. Macdonald of Dominion Glass Co., Ltd., and R. R. Underwood of Knox Glass Associates, Inc., whose terms expired.

The meeting was called to order by Mr. Gayner, who then presented Albert Mac C. Barnes, of Barnes, Richardson & Colburn, counsel to the GCMI on tariff matters. Mr. Barnes spoke on the forthcoming trade conference to be held in September at Torquay, England. He disscussed the classification of glass containers listed for negotiation for possible further reduction in United States import duties. In referring to the Havana Charter for an International Trade Organization, Mr. Barnes strongly emphasized the harmful effects upon the United States economy as envisioned by the American Bar Association should our country become a signatory nation to the I.T.O.

Left to right: M. A. Hellrung, P. W. Hatch, C. D. Rau and Fred Dundas.

Mr. Barnes also reviewed developments toward the abrogation of the recent decision in the Griffon Case relating to the proper rate of duty applicable to perfume and toiletry bottles imported under Par. 281 (E) of the Tariff Act of 1930.

The business sessions which followed were taken up with discussion of committee reports.

The Committee on Market Research and Promotion, headed by I. J. Collins, Chairman of the Board of the Anchor Hocking Glass Corporation, reported growing acceptance of the One-Way beer bottles and outlined plans for this year's promotion of the item, including joint merchandising tie-ins with brewers and allied food concerns. The report revealed a proposal by the Marketing Committee for a 10-week newspaper advertising schedule providing for the use of 1,000 lines weekly in a total of 48 daily newspapers in New York, Maryland, District of Columbia, Indiana, Tennessee, Texas, West Virginia, Ohio, Maine, New Hampshire, Michigan and Massachusetts. In addition, the Committee advised, the GCMI advertising agency, Foote, Cone & Belding, has developed a one-minute television spot to be tried out over a ten-week period over station WMAL-TV (Balti-

J. M. FOSTER

P. I. HEUISLER

J. C. CRAWFORD

more-Washington) Monday through Saturday. Other media to be used include radio, outdoor advertising and trade union publications, the latter in those key markets where the labor press is particularly strong.

The Committee also reported on the public relations phase of the merchandising program, including the results of a survey on the effectiveness of *Glass Container News*. The latter brought out the following points: (1) The *News* has an exceptionally high degree of readership at executive levels in both the grocery and brewery fields; (2) it has a very high degree of readership at all brewery and wholesale distributing levels; (3) it has only an average or slightly less than average readership at grocery levels below the executive group, and (4) its editorial content is highly approved by its readers.

These findings showed, the Committee observed, that the effectiveness of the *News* as a promotional medium would be enhanced by changing the mailing list to include more top-level, multi-unit executives and fewer owners of self-operated stores, and also by modifying certain details of editorial policy. The Committee also praised the Institute's public relations counsel, the Theodor Swanson Company, for its effective publicity efforts, which have resulted in widespread editorial mention, in newspapers, trade journals and labor publications.

Benjamin Wood, the Institute's Director of Marketing, broadly outlined the work of the Marketing Committee on beer promotion as well as milk and baby foods. He also reviewed the requirements for continuation of the one-way beer bottle program. R. L. Cheney, who directs the West Coast operation, described in detail the work and results in that area, where marked success has been achieved.

B. H. Taylor, Traffic Director of the Institute, presented the report of the Traffic Committee, which is headed by I. L. Dunnington of the Anchor Hocking Glass Corporation. In its report, the Committee weighed the effect of the last rail freight rate increase, and cited the Eastern railroads' concern over diversion of glass container traffic to highway carriers. On December 7, the Committee reported, it held a joint conference with representatives of the Eastern roads, and presented evidence showing the convenience of shipping glass containers by truck where distances do not exceed 300 miles. As a result, decreased rates were initiated by the roads and subsequently approved by the Interstate Commerce Commission. Based on the volume of shipments made in August, 1949, the Committee estimates that the revised schedule will reduce rail freight charges in the Official Territory $1,750,000 annually. Through similar methods, adjustments have also been obtained on shipments of soda ash.

The report also explored the rate situation applying to sand for glass manufacturing purposes, a problem on which it is working jointly with the National Industrial Sand Association.

The Committee on Government-Industry Relations, through its Chairman, S. B. DeMerell, outlined its activities in such matters as the trade agreements program; the controversy over current rates of duty applicable to perfume and toiletry bottles made on hand-operated equipment; contacts with government agencies, such as the Department of Agriculture on various food procurement programs; the dissemination of data on imports and exports of glass containers, compiled by the government, and circulation of information prepared by the National Canners Association on the volume of fruits and vegetables packed, especially those items, such as baby foods, catsup and chili sauce, where glass is extensively used.

The Committee also reported on the International Trade Organization including the consideration now being given by Congress to legislation committing the United States to become a signatory nation. As the result of an invitation from the House Committee on Foreign Affairs, the Trustees of the Institute adopted a resolution expressing disapproval of I.T.O., and this was submitted to the Chairman and members of the House Committee.

Mr. DeMerell's Committee also reported progress on the part of the research project at Battelle Memorial Institute, devoted to the development of a compact, efficient gas producer system. The project is being conducted by Battelle in cooperation with GCMI Bituminous Coal Research, Inc., and others.

The report of the Committee on Labor Relations, of which L. C. Roche of the Maryland Glass Corporation is Chairman, dealt principally with the renewal of agreement with the American Flint Glass Workers' Union. The contract, which includes an insurance plan extension, involved no increase in the minimum rates for mold makers, mold repairmen and apprentices.

This Committee also advised that an actuarial study of pension costs in the glass container industry is being made, in accordance with the agreement negotiated with the Flint and G.B.B.A. unions.

The Technical Committee on Glass Packed Products, headed by J. M. Sharf of the Armstrong Cork Company, reported on the research program at the University of Massachusetts. Among other things, it said that considerable progress has been made in the study of enzyme systems in acid foods, and that extensive work has also been carried on to improve the processing of fresh Kosher Style Dill Pickles.

The Committee also commented upon the other experimental projects being carried on at the University of Massachusetts and by other research organizations having to do with improvement of processing methods and equipment for glass packed fruits and vegetables.

In a review of its work, the Committee on Standards for Finishes, of which C. C. Green of the Armstrong Cork Company is Chairman, announced that all the former Glass Container Association drawings of glass finishes have been reviewed, clarified and adopted as GCMI specifications, except for drawings no longer active, which have been obsoleted. The Committee also reported specifically on six sets of finishes on which it has recently been active, the Amerseal Finishes, the Anchor Vacuum Side Seal Pry-off Finish; the Vacuum Side Seal Pry-off Finish; the Vacuum Side Seal Pry-off Finish for Baby Jars, and the Bead Finish for Jars without Shoulders.

Dr. F. W. Preston, of Preston Laboratories, discussed testing procedures.

The Committee on Container Design and Specifications, headed by J. M. Foster of the Foster-Forbes Glass Company, announced several new container drawings.

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OPPORTUNITIES FOR QUALITY CONTROL IN THE FLAT GLASS FIELD

By F. L. BISHOP AND F. W. MOWREY
American Window Glass Company, Arnold, Pa.

The possible uses of quality control techniques in the flat glass field are so numerous that to use all of them would require a staff of statisticians comparable to the accounting departments of the companies involved. For that reason we, as an industry, have only started the use of this powerful new tool.

Quality control techniques are of value because a relatively small amount of data gives limits to be expected, because a mathematical point is established for "out of control" measurements, and because comparisons between sets of data are possible.

This paper is limited to the possibilities for better technical control. It leaves to others the use of these methods in human engineering. Such problems, as the study of packing methods, are outside its scope. Furthermore, this paper does not say which of these opportunities have been followed out by any one company.

The first consideration in any manufacturing process is the finished product. Quality control methods are generally first applied to the measurements made on the finished product. Probably quality control methods are applied to density measurements more often than to any other factors in the glass industry. The work by Ghering[1] is unusually fine and complete. The measurement of index of refraction is said by some[2] to be superior to density measurements for control. In order to have a more complete picture of the variations in composition, these must be combined with other measurements. Chemical analysis of one or more components can be made by quick methods. Thermal expansion measurements are used.[3] Color measurements including ultraviolet and infrared made by spectrophotometer will give analysis for iron or for any colorants that may be used purposely or otherwise. Aside from these measurements which show variations in composition are measurements or counts of defects such as seeds, stone and ream.

Here is a very fertile ground for quality control charts, since these defects are subject to quick changes which may come from a variety of causes. While on this subject, the value of Dr. Preston's[4] work on Poisson series in finding clues to the origin of defects should be mentioned. Another group of tests of fairly universal value includes micro-hardness tests, modulus of rupture measurements and measurements of annealing by the polariscope.

Glass for special uses may be tested for distortion and flatness. Various methods are available for measuring durability. The quality control chart can show differences and whether or not they are significant.

The factors considered so far are resultant factors. They give a picture of the results obtained and indicate when corrective action is necessary. Causative factors are those which should be considered when resultant factors show lack of control. These causative factors are the least known since they constitute what has been the art of glassmaking.

We have all dreamed of the completely automatic glass tank with the equivalent of the push button tuning on your radio. In this tank, every temperature, pressure, and other factor would be automatically controlled. Unfortunately the factor of economics intervenes. Quality control methods can determine the possible value of automatic controls, and when they have been applied, the same method tells us whether they are working right.

Starting with routine analyses of the raw materials, quality control methods will soon tell whether it is necessary or desirable to test every shipment of each material or only spot check. The same methods apply to sieve analyses. One specific material such as celestite in the dolomite may be checked regularly in case of unaccountable excesses of salt water. (Notice that this requires an estimate or measurement of the salt water content of the tank.) After the batch is weighed and mixed, quality control techniques may be applied to determine the effectiveness of weighing and of mixing. Either batch insoluble measurements or sieve analysis as suggested by Burress[5] may be used.

Going next to the melting process, the efficiency of the tank as a whole may be studied by such methods as recommended by the furnace committee of the Society of Glass Technology.[6] Quality control techniques are quite applicable to the resulting values. Gas and flue gas analyses and excess air controls are fertile ground for investigation. Theoretically, all of the multitudinous temperatures measured and recorded are subject to analysis. Actually the "hot spot" and breastwall temperatures, and temperature differences between certain locations which govern the flow rates, should be analyzed. The flow rate itself may be determined regularly and plotted. Pressures and metal level are subject to control by automatic methods and, therefore, subject to quality control techniques.

Considering next the drawing or rolling process, it is again temperatures which must be controlled. These are many and varied. The temperature of the glass being formed and temperature differences across the sheet are obvious. Roll temperatures and temperature and amount of coolant should be handled by statistical methods rather than being set at some value resulting from "experience" which is likely to be the result of accident or combination of circumstances.

Quality control charts are valuable when applied to thickness measurements since they give a picture of the value of any automatic control method and can be used to justify the financial outlay.

When quality control charts show the need of an assignable cause, either for a point or points out of limits or for a trend in results, the most important use of control charts is brought to the fore. Resultant factors then must be compared with causative factors. A correlation

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Presented before the Eleventh Conference on Glass Problems, University of Illinois, Urbana, Illinois.

CONTINUED UNION-MANAGEMENT COOPERATION STIMULATES PROGRESS

By LEE W. MINTON, President

Glass Bottle Blowers Association of the U. S. and Canada-A. F. L.

When the automatic machine came into use in the glass container manufacturing field, the Glass Bottle Blowers Association had 10,000 members. At that time it appeared that union membership in this industry would steadily decrease due to the replacement of men by the machine.

Today, a quarter of a century later, the union has 38,000 members and is growing steadily. The constant expansion of the glass industry means a corresponding growth in union membership among employees of the industry. It is true that the hand glass blower received comparatively higher wages than does the machine operator of today. However, when the machine came into the industry, the members of our union knew that it was useless to attempt to fight technological progress as the weavers did without avail several hundred years ago. Therefore, the officials of the Glass Bottle Blowers Association advised union members to go to work on the machine.

The Glass Bottle Blowers Association dates back to 1846 and is one of the oldest unions in the United States. Since 1885 when national bargaining between the industry and the union was first initiated, there has not been a general strike in the industry.

The Convention of the Union to be held at Columbus, Ohio, June 19 to 27, will take up a number of important problems. This will include wages, working conditions and pensions. The current prosperity of the industry should be shared with the employees in the industry who make these profits possible. We believe that when the employees receive an adequate wage and the employers make a fair profit, we are sure to have labor-management harmony.

Management must, to be successful, be ready and willing to meet its labor problems with a patient degree of fairness. Production of staple goods requires more than the investment of capital—it requires the brain and hand of workmen who turn the capital investment into a finished product which will appeal to potential purchasers.

Labor must, to be successful, take into consideration the problems of management. Application of force, through superior numbers, will bring nothing but sacrifice and distrust. Labor must be ready and willing to give the employer its best efforts, keeping in mind the fact that its job opportunity is attained by the capital investment of the employer. It must constantly keep abreast of modern advancements in order to better meet the competition which makes progressive industry. It can keep disputes to a minimum by the application of fairness in dealing with management.

During the month of July each year, the representatives of the union and management meet in Atlantic City, N. J., to discuss and finally settle their problems for the coming contract year. These conferences consume a period of from three to five days. Proposals are presented by each side 60 days prior to the opening of the conference and each side is then prepared to fully present its case as well as to argue for or against matters affecting the interest of each group. The conferences are conducted on a high plane, without bitterness or tirades being evident from either side.

By applying the measure of common sense in labor negotiations, the glass container industry has received the reward of stability. It is assured through national collective bargaining that it will not be confronted with wildcat strikes during the term of its contract nor will it be forced to retard its progressive thinking because of strict rules against increased production.

Wage rates have advanced tremendously in the past ten years and the investor also has gained a larger degree of profit. The union has always stood for a fair margin of profit to the employer feeling that, in turn, the members of the union should thereby receive a fair and equitable portion of this increased return. The conferences which are held annually attempt to keep to a minimum local problems from upsetting the results of the national conference. The wage rates which are established in this conference are the same whether the employee is in the north or in the south.

The contract itself is kept simple, in order to be readily interpreted by anyone coming in contact with it. One of the most unique principles of this bargaining conference is that the president of the union, together with the secretary of the labor committee of The Glass Container Manufactures Institute, is empowered to adjust any dispute which may arise between conferences. If the two parties mentioned above are in agreement, the matter is final and binding upon both sides unless revoked by a future conference. If a settlement cannot be reached on a local basis, protests are entered by either the employer or the local union. These protests are given to the president of the union and the secretary of the manufacturers. They then discuss the matter and attempt to reach a final accord. If, however, these two parties

1951 Kaiser Special Sedan shown supported on four beer bottles at the Glass Bottle Blowers Union exhibit. Each visitor to the exhibit received a free chance to win the car.

Crowds swarm through the Glass Bottle Blowers booth at the Union Industries Show in Philadelphia. Total attendance at the Show exceeded 500,000.

cannot reach a decision, the matter then may be referred to a committee appointed by them. This committee would consist of three manufacturers and three officers of the union. During this period, the plant remains in operation and work continues.

In order to maintain secure employment for members of the Glass Bottle Blowers Association, the union has been active in promoting the increased use of glass containers by sixteen million union families and the general public. Each year since 1946, we have expended union funds for this purpose as we feel it is a responsibility of the union as well as of industry to see that there is sufficient sales volume to assure steady employment and good wages. This year the union will spend $15,000 in the Labor Press to promote the sale of glass containers. In addition, the union participates in such events as the giant AFL Union-Industries Show which took place recently in Philadelphia, May 6-13. This show drew an attendance of over 500,000 who saw an exhibition of the products made by union members. The Glass Bottle Blowers Association had one of the most outstanding exhibits at the show. One large animated display featured the one-way, no deposit beer bottle and pointed out the reasons why the public should buy them. Another moving display demonstrated the advantages of glass milk bottles and other glass containers for foods and beverages. A puppet show was also featured in which two of the characters were a milk bottle and a one-way beer bottle. They, together with puppets representing the American worker and a housewife, sold the public on why it pays to buy food and beverages in glass containers.

A typical display of the GBBA at the Union Industries Show.

A Kaiser Sedan weighing 3,150 pounds was supported on four one-way bottles to show the strength of these glass bottles. The car was given away by the union at the end of the show to one of 100,000 people who filled out contest blanks for the car. Their names and addresses will be made available to the Glass Container Manufacturers Institute for use as a mailing list.

Another campaign sponsored by the union which drew national attention, ran in Ohio the early part of this year. The Zanesville, Ohio area was threatened by an invasion of the paper milk container. The union decided to combat this threat to glass workers' jobs by conducting a test campaign in this area. A series of large newspaper ads were run in the Zanesville and Mount Vernon, Ohio daily papers as well as in the weekly labor paper. A fifteen-minute program featuring noted Hollywood stage and screen stars was broadcast on the Zanesville radio station each week for thirteen weeks. A prize was offered of a large television set for the best slogan on "Why It Pays To Buy Milk In Glass Bottles". The Mayor of the city of Zanesville gave a short talk on the radio introducing the campaign, and praised the Glass Bottle Blowers Association as a sound, progressive organization which deserves support. The Mayor as well as the Superintendent of Schools and a union official were judges of the contest.

The Zanesville Times Recorder Signal, which has a 38,000 daily circulation, sent out letters to all grocery stores in the area telling them about the campaign and urging them to cooperate with it. The drive was a huge success. Over 2,000 people entered the contest and submitted slogans. The winner was Mrs. Gladys Metzger of Dresden, Ohio, whose winning slogan was "Be Sure of Quantity, Quality, Cleanliness and Purity—Buy Milk In Glass Bottles for Security". One of the local dairies reports that the campaign "stopped the growth of the paper container in its tracks". All the dairies in the city cooperated with the campaign by offering weekly prizes of thirty quarts of milk to three different winners each week of the thirteen weeks of the drive. The successful

(*Continued on page* 334)

THE NATURE OF GLASSES AND GLAZES AND THEIR HARDNESS

By DR. FELIX SINGER, Consulting Ceramist

PART II

Historical Development

As a result of M. v. Laue's discovery of the diffraction of X-rays by crystals in 1911, physicists began to study crystal structures by means of monochromatic X-rays. It was found that many simple inorganic compounds can be considered as packings of spheres of constant sizes for any element or ion. In ionic compounds, ionic charge and size are the first essentials governing the atomic arrangement. In 1927 V. M. Goldschmidt[11] discussed the properties which characterized those inorganic compounds which were capable of forming glasses under appropriate conditions of cooling. Goldschmidt[10] was the first to recognize the importance of the tetrahedral coordination and the ratio of ionic sizes for glass formation. This picture has been elaborated by his collaborator W. H. Zachariasen,[20] whose theory met with great success as he was not only able to give a logical reason why certain oxides have a greater tendency to form glasses than others, but even to make predictions in this respect which later have been proved correct by experiment.

In the meantime, the atomic arrangement in many silicates had been determined, chiefly by W. L. Bragg and his associates, and this information was essential for the more detailed work on glasses undertaken since 1936 by B. E. Warren and his collaborators.[21] Using refined methods of experiment and calculation, Warren has built up most of our present knowledge of the atomic arrangements in inorganic glasses and glazes. His data gives excellent support to the Goldschmidt and Zachariasen theories.

Atomic Arrangement in Ionic Crystals Including Silicates

In order to present the atomic arrangements in glasses, it is necessary first to describe the corresponding arrangements in crystalline systems of similar chemical composition.

The general principles governing crystal structures of ionic crystals have been developed chiefly through the work of W. H. Bragg, W. L. Bragg, V. M. Goldschmidt and L. Pauling. The crystals can be considered as packings of spherical ions cations having less anions and more electrons than the corresponding neutral atoms. The forces holding the crystals together are electrostatic bonds. As a first approximation, the ions are incompressible spheres of constant size which pack together as tightly as possible, cations being surrounded by anions and vice versa. Highly charged cations tend to be separated from each other as far as possible. The number of nearest neighbors for any given ion is governed by consideration of ionic sizes, usually expressed as ionic radii. Taking oxygen as an example, radius about 1.32 Å (1Å — 10^{-8}cm) a cation of 0.2 Å radius is surrounded by three oxygens forming the corners of an equilateral triangle. This is observed in several borates where the units $(BO_3)^{-3}$ occur. Slightly larger cations of radius 0.3 to 0.4 Å fit into the holes made by four oxygen spheres in contact with each other. This occurs in silicates and phosphates and where the units $(SiO_7)^{-4}$ and $(PO_4)^{-3}$ build up the crystal structures. Still larger cations of 0.6 to 0.8 Å radius tend to be surrounded by six oxygens which occupy the corners of an octahedron, as in corundum (Al_2O_3), or periclase (MgO).

The radii of the ions can only be considered as approximately constant, as modifications have to be introduced for the particular type of environment and polarization. Polarization can be considered as a deviation from the spherical symmetry of the ions and depends on the mutual effects of cations and anions. Among the latter, F^{-1} and O^{-2} are less polarizable than Se^{-2} and S^{+6} and C^{+4} polarize more than P^{+5} and Si^{+4}. The following

TABLE I

Ionic Potentials of Cations Used in Glasses

Cation	*Ionic Radius*	*Valence Radius or "Ionic Potential"*
Li^{+}	0.68	1.5
Na^{+}	0.98	1.0
K^{+}	1.33	0.75
Rb^{+}	1.48	0.68
Cs^{+}	1.47	0.60
Be^{++}	0.31	6.5
Mg^{++}	0.71	2.8
Ca^{++}	0.99	2.0
Sr^{++}	1.13	1.8
Ba^{++}	1.35	1.4
Zn^{++}	0.74	2.7
Cd^{++}	0.97	2.1
Pb^{++}	1.21	1.7
B^{3+}	0.20	15.0
Al^{3+}	0.50	6.0
As^{3+}	0.69	4.3
Sb^{3+}	0.90	3.3
Si^{4+}	0.41	9.8
Ti^{4+}	0.68	5.9
Zr^{4+}	0.80	5.0
Ce^{4+}	1.01	4.0
Ge^{4+}	0.53	7.5
Sn^{4+}	0.71	5.6
Pb^{4+}	0.84	4.8
P^{5+}	0.34	14.7
As^{5+}	0.47	10.6
Sb^{5+}	0.62	8.1

Ionic Size of Anions Used in Glasses

O^{2-}	1.40	F^{-}	1.33
S^{2-}	1.85	Cl^{-}	1.81
Se^{2-}	1.96	Br^{-}	1.96
Te^{2-}	2.18	I^{-}	2.19

table shows the ionic potentials of cations generally used in glasses and glazes, and the ionic size of anions used in glasses and glazes.[10]

The oxygen ion is outstanding owing to its size. In comparison with the sizes of other ions generally used in glasses and glazes, it is not only that it is the largest but the differences are so great that the structure of, for example, a sodium-lime-silicate, can be described as a packing of oxygen ions containing silicon, sodium and calcium ions in its interstices. The Si^{4+} ion has a size less than one-third that of the oxygen ion but it possesses strong attractive forces for the surrounding oxygen. Due to its small size, it can accommodate not more than four oxygen ions. All oxygen ions are of the same size and can be considered rigid spheres, repelling each other. The assumption is made that each ion is characterized by its size, its charge, and by the grouping of the electrons around the positive nucleus. It is not strictly possible to represent an ion by an exact sphere of a size which just includes the electrons, but for many purposes this simple picture has served. As two ions approach each other, strong repulsive action is rapidly set up and prevents further approach, which means that the two ions act like two rigid spheres. The binding energy is the consequence of electrostatic forces.

The conditions described lead to the assumption that a group of oxygen ions, all of the same size, considered as rigid spheres repelling each other, show a symmetrical arrangement. Goldschmidt[11] has shown that the centers of the oxygen ions around each silicon ion form the corners of a tetrachedron. Larger cations can accommodate round themselves a larger number of oxygen ions. From merely geometrical considerations, the conclusion is reached that the number of anions which will surround each cation is chiefly dependent on the ratio of ionic radii. Based on such considerations the co-ordination number can be calculated as a function of the ratio: $R_{Cation} : R_{Anion}$.

For the main glass and glaze-forming oxides, the following picture is obtained[10]:

"(a) Boron is surrounded by three oxygens, the centres of which form the corners of a regular triangle.

"(b) Silicon is surrounded by four oxygens, the centres of which form the corners of a regular tetrahedrog. The same group has been found for the Al^{3+}, Be^{++}, B^{3+}, Zn^{2+}, Mg^{2+} and the ferric ion.

"(c) Calcium can accommodate six oxygens, the corners of which form a more or less regular octahedron. The same arrangement has been found for Al^{3+}, Fe^{3+}, Mg^{2+}, Mn^{2+}, Ni^{2+}, Co^{2+}, Cr^{3+}, Ti^{4+}, Li^{+}, Zn^{2+}, Cd^{2+}.

"(d) Sodium like other big ions, such as K^{+}, Sr^{2+}, Ba^{2+}, Zr^{4+}, can accommodate round itself seven to twelve oxygens, but such a group has a much lower symmetry than the previous smaller groupings.

"One and the same ion may occur as the centre of difference configurations. With increasing temperature, this implies stronger thermal motion, and the number of oxygens surrounding each cation decreases as a rule. In the crystal lattice an ion has a definite number of oxygens as neighbours, since the co-ordination number is more or less fixed by the lattice symmetry. This is not the case, however, in glasses. As there is no symmetry, each cation has different co-ordination numbers and if a co-ordination number is quoted it is an average value. In borosilicate glasses, for instance, we know that some of the boron atoms are surrounded by three oxygens and the rest by four. We might, therefore, speak of an average co-ordination number of boron."

The fact that some of the boron atoms are surrounded by three oxygen ions and others by four is one of the most important discoveries explaining not only the "boric oxide anomaly" but a great number of observations both in glass and glaze research which will serve further developments to a very much greater degree.

As mentioned above, the units $(SiO_4)^{-4}$ are pictured as tetrahedra with oxygen at the corners and silicon in the center, the edge of the tetrahedron being about 2.6 Å (O — O distance) and the distance from the center to one corner about 1.6 Å (Si — O distance). These silicon-oxygen tetrahedra are the basal units in all crystalline forms of silica and silicates, and indeed in glasses and glazes based on silica. The tetrahedra occur as separate units in the orthosilicates such as olivine: $(MgFe)_2 SiO_4$. where the ratio of oxygen atoms to silicon atoms is four. With a lower oxygen-silicon ratio, sharing of oxygen ions between two tetrahedra occurs but the general rule holds that any given two tetrahedra can only share one corner. Thus the metasilicates form strings of tetrahedra as in enstatite: $Mg\ SiO_3$ where any given silicon is surrounded by two shared and two unshared oxygen ions. Double strings of tetrahedrae occur in the amphiboles based on the units $(Si_4O_{11})^{-6}$.

With a still lower oxygen silicon ratio, layer lattice silicates are formed with sheets of tetrahedrae based on the units $(Si_2O_5)^{-2}$, where three out of four oxygen ions are shared. In alumino-silicates the aluminium is sometimes found in four-fold co-ordination, that is to say in the places where a silicon would be expected and in these cases it really plays the role of the Si^{4+} ion. However it may also occur in six-fold, or octahedral, co-ordination. In the layer lattice mineral, muscovite, a member of the mica group, of composition: $K\ Al_2\ (Si_3Al)\ O_{10}\ (OH)_2$, two-thirds of the aluminium are in six-fold co-ordination, surrounded by four oxygens and two hydroxyls, while one-third, written with Si in the formula above, is in four-fold co-ordination between four oxygens.

Alumina[10] (Al_2O_3) cannot be considered a glass-former by itself, because it does not fulfil the requirements which according to V. M. Goldschmidt[11] are essential for glass formation, namely:

"(1) It cannot form a three-dimensional network of $Al\ O_4$ tetrahedra as for the purpose the O: Al ration of 3.2 — 1. 5 is too low, 2.0 being the minimum.

"(2) It cannot form a three-dimensional network of $Al\ O_3$ triangles, as boric oxide does, as, for a three-fold co-ordination the ratio $F_{Al} : R_O = \frac{0.57}{1.32}$ is much too high. The Al^{3+} ion ranges between those ions which prefer tetrahedral and those which prefer six-fold or octahedral co-ordination."

"In crystalline silicate, $Al\ O_4$ groups are often found to take the places of $Si\ O_4$ groups."

In quartz, tridymite and cristobalite, the crystalline forms of silica, and the oxygen silicon ratio is two and the $(SiO_4)^{-4}$ tetrahedra form a three-dimensional network, every oxygen being bonded to two silicon ions, with the bond angle Si — O — Si varying from about 140 to 180°. Similarly, in the feldspar there is a three-

dimensional network of tetrahedra, but aluminium is substituted for some of the silicon. However, Al^{3+} has only three positive charges against four of SiO^{4+}. To replace SiO^{4+} by Al^{3+} electrical balance has to be attained by introducing into the structure together with each Al^{3+} another ion with a single positive charge like Na^{+}. For example, should the half of the SiO_4 tetrahedrae in the cristobalite structure be substituted by AlO_4 tetrahedrae a suitable number of sodium ions have to be brought into the lattice to obtain electro neutrality. This replacement of Si^{4} by Na^{+} Al^{3+} produced the structure of carnegieite which is isomorphous with the high-temperature form of cristobalite. It is not only possible to substitute half the SiO^{4+} by Na^{+} Al^{3+}, but if the replacement is complete:

$Si\ Si\ O_4$	$Na\ AlSiO_4$	$Na_2\ Al_2\ O_4$
cristobalite	carnegieite	sodium aluminate

the cristobalite structure is unchanged.

"The same considerations are valid for the vitreous state. Addition of Al_2O_3, therefore, makes a sodium silicate glass resemble one of higher acidity."

While in very many cases a certain amount of alumina has a favorable effect on one or other property of a glass and a glaze, an increased amount produces the contrary effect, and this is so pronounced that one even could speak of an "alumina anomaly" very similar to the well known "boric oxide anomaly". Considering Weyl's statement[10] that "from a chemical viewpoint the aluminosilicates are similar to the borosilicates", a further comparison of both "anomalies" might be of general interest. I have previously reported[8] about the alumina content of glass and glazes with the conclusion: "that there is a definite limit to the amount of alumina which can best be introduced into each type of glass." However this *limit* varies in very wide ranges. Parmelee and Badger[22] came to the following results, but these only apply to a special type of glass:

"(1) The addition of 2% of alumina, Al_2O_3 increases the melting time at the lower temperature while further additions have a less pronounced effect. At the higher temperature the melting time is not so markedly raised and the increase in melting time is nearly a linear finction of the alumina additions.

"(2) On increasing the alumina contents from 0 to 10%, the softening temperature of the particular glass under experiment rises from 580° to 620° C."

However we get a completely different picture of suitable alumina contents of glazes and their limits if we take the average of alumina contents in standard soft porcelain glazes for cone 8 which is about 12 to 13% while the limits are between 10.4 and 17.5%.[6] They show within which very wide limits the alumina content can vary.

I have reported[8] that Seger[23] has "found that, with low alkali and high lime contents the introduction of a suitable amount of alumina led to the production of clear and brilliant glazes."

I summarized by saying[8]: "alumina has long been recognized as the oxide which has the greatest effect on durability, and it is now very rare to find glazes in which it is not present."

Previously[8] I have reported: "interesting information regarding the order in which the most common minor constituents improve the resistance of glasses against scratching.[24, 25] (1) Boric oxide, (2) Alumina, (3) Barium oxide, (4) Magnesia, (5) Zinc oxide."

It is quite well known that the boric oxide anomaly concerning "hardness" is very pronounced; naturally different glasses and glazes showing correspondingly different figures. It is reported, however, though it seems to be less well-known, that a similar alumina anomaly occurs if increasing alumina contents are introduced into ceramic glazes. It has been mentioned that first of all the brilliancy is improved, but later lost. During this process the hardness was improved to such a degree, that generally matt glazes, the mattness of which is based on a high alumina content, are more resistant against scratching than the similar brilliant glazes. As soon as the alumina content passes this optimum some hardness is lost again.

I have collected similar experience with other properties: chemical resistance, transparency, smoothness, vitrification. Naturally the optima of the alumina contents differ very considerably not only in relation to other ingredients of the glaze, to the whole composition, but also to the burning temperature, the burning time and the body to which these glazes are applied (in all these cases we have to consider the chemical and physical reactions between body and glaze).

These similarities of boric oxide and alumina in glazes, the "boric oxide and alumina anomalies" find a complete explanation in the structure of alumina and borosilicate[10].

L. Pauling[26] described the formation of a crystal from its single ions and complex radicals and the principles governing this process. As a result of his research he stated that the structure is such that the potential energy has a minimum value. This energy is mainly electrostatic. If the total positive and negative charges are equal, the chemical rules of valency and stoichiometric ratio are fulfilled. This is not always done by building up the structure of individual positive and negative ions. Around each positive ion there are a number of negative ions, and of negative ions round a positive.

All silicates, despite their variable composition and crystal forms, show in their atomic arrangement certain similarities which can be set out as follows[10]:

"(1) The structural element is the SiO_4 tetrahedron. In order to form tetrahedra which are independent, the oxygen silicon ration has to be at least 4:1. Such is the case in all orthosilicates.

"(2) One oxygen may belong to two tetrahedra simultaneously. This interlinkage of tetrahedra leads to chains, and to two or three-dimensional networks, as well as to combinations of these units. It occurs whenever the oxygen: silicon ratio is smaller than 4:1.

"(3) Two SiO_4 groups cannot share more than one oxygen, which means that two tetrahedra may share one corner, but not an edge or face.

"(4) In none of the structures so far investigated can SiO_2 be considered as a self-sufficient group or molecule. In other words, the molecule SiO_2 does not exist in the crystalline state."

"The different forms of silica, corresponding to the composition SiO_2, have an oxygen: silicon ratio of 2:1. Each oxygen therefore belongs to two tetrahedra. This sharing of all oxygens causes a strong bond and interlinkage between the tetrahedra, so that the transforma-

(*Continued on page* 326)

ALLEGED BRITTLENESS OF GLASS AT LOW TEMPERATURES

In a number of articles put out by State Agriculture Extension Services, we find a statement or a hint that glass is more brittle at low temperatures than at warmer ones. We have written to every such Extension Service and asked what the evidence is on this point, because it is quite contrary to our own investigation of the strength of glass.

The Extension Services we have written to are those at Fayetteville, Arkansas (Professor Marshall C. Heck, author); Raleigh, North Carolina (Dr. Ivan D. Jones, author); Brookings, South Dakota (Professor Maud E. Stitt, author); Pullman, Washington (Professor Inez Eckblad, author); and Madison, Wisconsin (Professor O. B. Combs, author). Replies have been received from Arkansas, North Carolina and Wisconsin, all of them indicating a retraction of the statement and saying that they have no basis for a statement as to relative ease of breakage with temperature.

So far as we know at this laboratory, there is no evidence that low temperatures as such do anything harmful to the glass. Changes of temperature, of course, especially rapid ones, are another matter. Glass is used very successfully at the lowest temperatures that science can achieve, far lower than anything that food ever has to encounter, and we have every reason to believe that all kinds of glass increase in strength rather than diminish, when the temperature is lowered.

F. W. Preston
Preston Laboratories

BURNHAM B. HOLMES NAMED ASSISTANT TO EDMUND BALL OF BALL BROTHERS

The appointment of Burnham B. Holmes as assistant to Edmund F. Ball, President of Ball Brothers Company, has been announced.

Mr. Holmes is a graduate of the University of Illinois College of Commerce. He was formerly associated with the Sugar Creek Creamery Company and from there went to the Knoxville, Tennessee, plant of the same organization. In 1938, Mr. Holmes accepted a position with the Inland Container Corporation in Indianapolis where he was assistant to the Vice President in charge of Sales.

ASSOCIATION OF AMERICAN RAILROADS ISSUES ORDER

The Association of American Railroads has issued a new order on Eastern Carriers to return box cars empty to eleven major Western Railroads.

The new order, which became effective April 12, supersedes an earlier one which directed that cars of different ownership could be used only when loaded and sent, without intermediate stops, to Chicago, Peoria, St. Louis, Memphis, New Orleans and beyond.

It is alleged that the original order did not result in the return of box cars in sufficient numbers. The order results in Eastern Carriers being required to return cars of the eleven Western Roads ownership empty, westbound, instead of loading them through the Western and Southern junction points. This has resulted in a somewhat acute box car situation in this area although, at the present time, there has been no real shortage.

DIAMOND ALKALI ANNOUNCES PRICE INCREASES

Diamond Alkali Company has announced an increase in prices of liquid chlorine in single and multi-unit tank cars, with nine quantity differentials for shipments in ton containers. It also announced an increase of $2.00 per ton in carload prices of light and dense soda ash, and an increase of $3.00 a ton in carload prices of liquid, solid and flake caustic soda. The new prices are effective July 1.

Prices on multi-unit tank car liquid chlorine shipments, for an annual period, to contract customers and only to one destination, are as follows: 165 tons and more, $3.05 per cwt.; 105 tons to 165 tons, $3.25 per cwt.; 90 tons, $3.50 per cwt.; 75 tons, $3.75 per cwt.; 60 tons, $4.00 per cwt.; 45 tons, $4.50 per cwt.; 30 tones, $5.00 per cwt.; 15 tons, $6.00 per cwt.; 8 tons on special truck, $7.00 per cwt. The new price on liquid chlorine in single-unit tank cars will be $2.55 per cwt.

All prices are f.o.b. Diamond's plants at Painesville, Ohio; Baldwin, Arkansas; and Houston, Texas. Multi-unit tank cars are not available at Baldwin. All Edgewood, Maryland chlorine prices are ten cents per cwt. higher than above. Terms remain net 30 days from date of shipment.

WYANDOTTE NAMES PATENT DEPARTMENT HEAD

The appointment of Merton B. Lilly as head of the Patent Department of Wyandotte Chemicals Corporation has been announced by Dr. Thomas H. Vaughn, Vice President in charge of Research and Development.

Mr. Lilly holds degrees in both chemistry and law and comes to Wyandotte from the patent law firm of Owen and Owen of Toledo, following broad experience in all phases of patent work.

After his graduation in law from the University of Maryland in 1940, Mr. Lilly was with Western Electric Company working in patent searches and patent applications and then as a chemical development engineer. In 1944, he joined Battelle Memorial Institute as head of a newly organized patent department. In 1949, he joined Owen and Owen. He succeeds William R. Day, who was recently named assistant to the president.

NEW CANADIAN GLASS-BLOWING PLANT

A glass-blowing plant, believed to be the first of its kind in Canada, will commence operations shortly in Chicoutimi, Quebec, a northern Canadian center, with the plant to be owned by L. Libby.

It is expected to give employment at the start to approximately 100 women and a smaller number of men. Production will include glass ornaments, among other items, such as colored Christmas tree bulbs.

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Annealing

Hartford Lehr. Fig. 1. Patent No. 2,507,673. (Four sheets of drawings.) Donald G. Merrill assigned this invention to Hartford-Empire Company. The patent relates particularly to controlling the drift in the lehr tunnel so as to maintain the desired heat gradient.

The general outside structure of the lehr is along conventional lines. Inside the tunnel there are a series of temperature sensitive elements which act independently to control the drift and, therefore, the temperature of the tunnel. The figure shows a section through the cold end of the lehr in which cooling air from a blower 22 is discharged at intervals from a pipe 4. Deflectors 6 and 7, and a damper 23 are controlled by a motor 33 which, in turn, is controlled by the temperature sensitive elements.

In order to get any general idea of this invention, it will be necessary to make a study of the patent which contains 16 claims.

The following references are of record in the file of this patent: United States Patents: 1,974,058, Wadman, Sept. 18, 1934; 2,106,678, Merrill, Jan. 25, 1938; 2,120,452, Amsler, June 14, 1938; and 2,238,791, Dorsey, Apr. 15, 1941.

Feeding and Forming

Glass Press. Fig. 2. Patent No. 2,505,997. (Three sheets of drawings). This invention was made by John B. Sisson of Marion, Ind.

The machine comprises a cylinder 15 carrying a number of rows of molds 14. Glass is delivered to these molds from a feeder 10 from which gobs are severed by shears 11 and dropped into a chute 13 which directs them to the molds. Above the cylinder 15 there is another cylinder 37 carrying a corresponding number of pressing plungers 83. The lower cylinder is driven by a Geneva movement and the upper cylinder is driven from it by a chain 42 and suitable sprockets. The upper cylinder is periodically moved toward the lower cylinder to perform the pressing operation by connections to a cam 31.

In this way, each row of molds and plungers may be of a different shape and a wide variety of articles may be made at the same time. After the pressing operation, the ware cools at the next station and is then ejected into a chute 16 which delivers it to a conveyor belt 17.

The following references are of record in the file of this patent: United States Patents: 430,701, Smith, June 24, 1890; 483,663, Warren, Oct. 4, 1892; 994,806, Wanko, June 13, 1911; 1,125,895, Bingham, Jan. 19, 1915; 1,125,916, Schneider, Jan. 19, 1915; 1,672,884, Bristol, May 10, 1927; 1,906,561, Flexon, May 2, 1933; and 2,250,515, Williams, July 29, 1941.

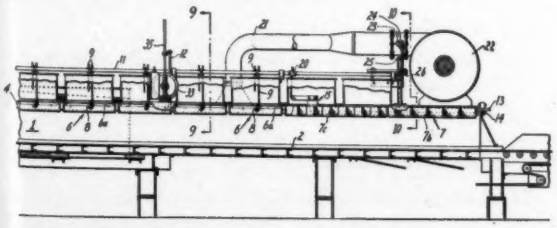


Fig. 1. Hartford Lehr.

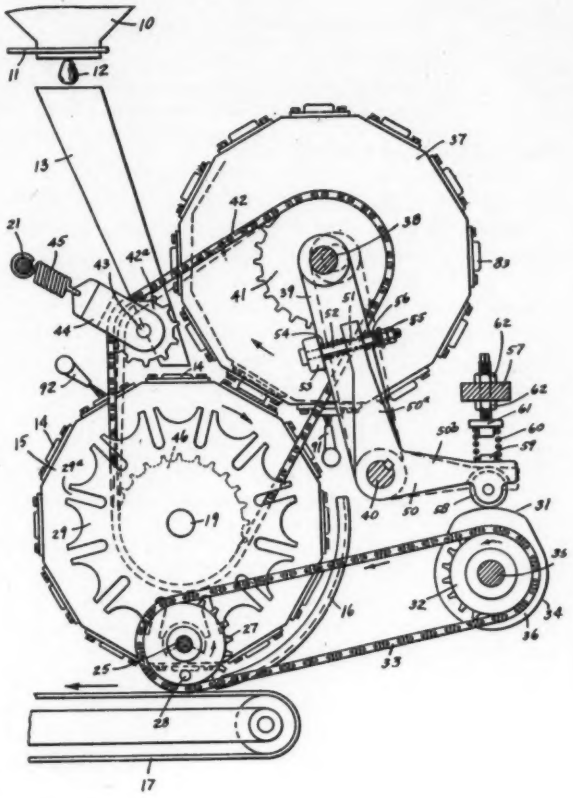


Fig. 2. Glass Press.

Press for Electric Discharge Tubes. Patent No. 2,507,441. (Five sheets of drawings.) This invention made by Charles F. M. Marchant of Wandsworth, England, was assigned to The Mullard Radio Valve Company, Ltd., of London. None of the drawings are reproduced here.

Molding dies are supported on two concentric tracks, the outer track having gear teeth driven by appropriate gears and the inner track having gear teeth driven by the same gearing so that the two tracks travel together.

At one station the pins are inserted in the die which then moves to preheating stations. The charge of molten glass is dropped into the mold and a pressing plunger is actuated. The operator presses a foot pedal to eject the molded base at a later station and the machine is ready to repeat its cycle.

The following references are of record in the file of this patent: United States Patents: 140,927, Kloman, July 15, 1873; 829,530, Kuhlewind, Aug. 28, 1906; 1,156,446, Taylor et al., Oct. 12, 1915; 1,326,765, Miller,

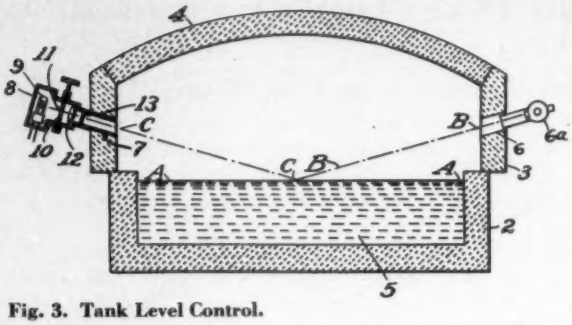


Fig. 3. Tank Level Control.

Dec. 30, 1919; 1,699,538, Keller et al., Jan. 22, 1929; 1,730,572, Hansen, Oct. 8, 1929; 1,900,455, Maynard, Mar. 7, 1933; and 2,406,297, Johnston, Aug. 20, 1946.

Furnaces

Tank Level Control. Fig. 3. Patent No. 2,503,770. (Two sheets of drawings.) This patent was assigned to Frazier-Simplex, Inc., by Philip W. Robinson. The patent discloses a source of light which is projected onto the surface of the molten glass in the tank and then reflected to a translating device which regulates the batch charging motor in accordance with the reflection which has been received.

The figure shows a cross-section of a glass melting tank of the usual construction. A light projector 6a throws a beam of light which may be any color, but is preferably violet or ultraviolet, along the lines indicated to the surface of the glass and then to a device including a photo-cell 9 and a relay which acts to vary the rate of feeding the batch to the furnace in accordance with the indicated glass level. The patent discloses several details of construction useful in carrying out the practice of this invention.

The following references are of record in the file of this patent: United States Patents: Re. 19,788, Amsler, Dec. 17, 1935; 1,706,857, Mathe, Mar. 26, 1929; 1,739,373, Race, Dec. 10, 1929; 1,928,016, Halbach et al., Sept. 26, 1933; 1,939,088, Styer, Dec. 12, 1933; 1,991,192, Bucky, Feb. 12, 1935; 2,037,925, Rentschler, Apr. 21, 1936; and 2,118,651, Macchi, May 24, 1938. Foreign Patents: 853,118, France, Mar. 11, 1940; and 128,833, Australia, Sept. 2, 1948.

Glass Compositions

Ultraviolet Transmitting Glass. Patent No. 2,505,001. (No drawings.) Corning Glass Works acquired this invention from Martin E. Nordberg. This glass has a low coefficient of thermal expansion and it is substantially transparent to wave lengths down to 254 millimicrons. The glass contains over 95% SiO_2.

In carrying out this invention, a preformed tube comprising a porous silica skeleton made in accordance with Patent No. 2,106,744 is slowly heated up to 600 to 900°C. after which the furnace is evacuated and the temperature is increased to about 1225°C.

Claim 1 of the patent is as follows: In the process of manufacturing ultraviolet transmitting glass, the steps of forming a glass article of high silica content having throughout its mass a multiplicity of submicroscopic intercommunicating pores, heating the article in an atmosphere of a reducing gas which contains hydrogen, and thereafter heating the article in a substantial vacuum to a temperature insufficient to fuse it but sufficient to consolidate it to a non-porous condition until consolidation is complete.

The following references are of record in the file of this patent: United States Patents: 1,628,468, Miller, May 10, 1927; 1,779,176, Long, Oct. 21, 1930; 2,215,039, Hood et al., Sept. 17, 1940; and 2,355,746, Nordberg, Aug. 15, 1944.

Acid-resistant Enamel. Patent No. 2,507,691. (No drawings.) William W. Coffeen and Ralph R. Danielson assigned this invention to Metal & Thermit Corporation. The enamel is for application to metals such as cast iron and its opacity is such that the thickness of the coating may be less than that commonly employed while getting the same or better results.

The patent gives several examples of compositions coming under the claims and detailed directions for practicing the invention, but the gist of the invention may be summarized by Claim I which is as follows:

An opaque, acid resistant enamel frit consisting essentially of the following components, based on the melted composition of the frit, in amount defined by the following concentrations, the latter being in terms of parts by weight:

SiO_2	30 to 50
TiO_2	2 to 15

the sum of the foregoing two ingredients always being in the range of 35 to 55,

B_2O_3	3 to 10
R_2O	6 to 20

in which R_2O is an alkali metal oxide selected from the class consisting of Na, K, and Li oxides,

PbO	6 to 20
F	1 to 8

the F exceeding 2.5 when the PbO exceeds 10.

MoO_3	2 to 8
RO	4 to 15

in which RO is an oxide selected from the class consisting of CaO, BaO, and ZnO.

The references cited by the Patent Office were Goodwin, No. 2,245,541, dated June 10, 1941, and Morris, No. 2,294,760, dated Sept. 1, 1942.

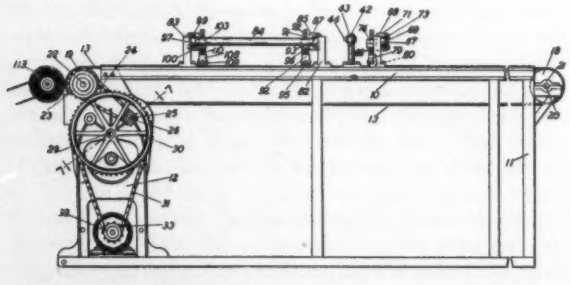


Fig. 4. Glass Cutting Machine.

Sheet and Plate Glass

Glass Cutting Machine. Fig. 4. Patent No. 2,504,655. (Five sheets of drawings.) This invention made by John Dallas of Wheeling, W. Va., consists of an endless belt

13 passing around rolls 18 and 19, one of which is driven by a motor 33. The belt carries the sheets to be cut and it is of a particular construction which carries the glass without slipping or creeping.

Posts 42 carry a rotatable glass cutter or a diamond, if preferred, suitable means being provided for adjustment and varying the tension of the cutter. Several sets of rollers are provided to keep the sheet under control at all times. As the sheet advances it comes to the breaking rollers 109 where the center of the sheet is raised slightly so as to break the glass along the scored line. The glass sheet passes to the right in the figure and the belt 13 is cleaned, after the glass is removed, by a brush 113.

The following references are of record in the file of this patent: United States Patents: 1,324,219, Waterloo, Dec. 9, 1919; 1,946,356, Owen, Feb. 6, 1934; 1,972,210, Waldron, Sept. 4, 1934; 1,996,387, Owen, Apr. 2, 1935; 2,150,391, Morris, Mar. 14, 1939; and 2,158,900, Goffaux, May 16, 1939.

Method of Making Plate Glass. Fig. 5. Patent No. 2,505,103. (Three sheets of drawings.) This patent belongs to Pittsburgh Plate Glass Company, having been assigned to it by Manson L. Devol. The main feature of the invention resides in the provision of rollers, to determine the thickness of the glass, having a film of air on their surface to prevent direct contact between the metal and the glass.

The patent shows three different embodiments of the invention, the first of which is reproduced here. A tank 9 is shown having the usual means for heating and connected to a hopper 24 from which the glass flows vertically downward to form a sheet 27. Burners 32 provide heat for the hopper while it may be cooled as needed by chilling passages 28.

As the sheet leaves the hopper, it is engaged by rollers 33 which rotate at a speed of perhaps 2000 to 4000 inches per minute peripheral speed. This feature is shown in Patent No. 2,387,886 to Devol. The speed carries a film of air on the surface of the rollers so that there is no direct contact between the glass and the metal. This produces an exceptionally smooth sheet of uniform thickness. The sheet then passes over a curved apron 34 backed up by an air chamber 38 which prevents damaging the glass by direct contact with the apron. The sheet then moves off horizontally over another apron 47 backed up by a similar air pressure box 48. There are eleven references cited by the Patent office.

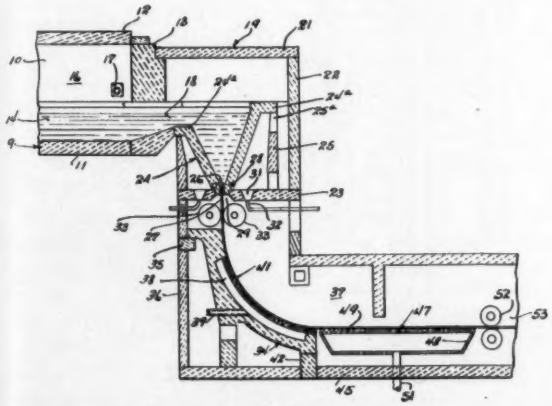


Fig. 5. Method of Making Plate Glass.

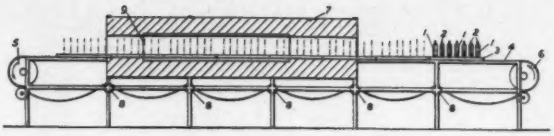


Fig. 6. Tube Forming Machine.

Tube and Cane Machines

Tube Forming Machine. Fig. 6. Patent No. 2,507,300. (One sheet of drawings.) Samuel J. Everett of Thornton Heath, England, made this invention which relates particularly to the formation of tubes having extremely accurate bores such as used in hypodermic syringes.

The figure here reproduced shows the method of forming short lengths of tubing, but the patent also shows the device for forming longer lengths. As shown here, pieces of tubing 1 are placed over mandrels 2 carried by a conveyor 4 passing through a furnace 7. After cooling, the tubes are removed from the mandrels and if the size is not right, they are put through another treatment.

The patent gives recommended temperatures and speeds for the conveyor. Graduations and other markings may be applied to the tube at the same time if desired.

The following references are of record in the file of this patent: United States Patents: 1,999,525, Morscholz, Apr. 30, 1935 and 2,215,041, Hostetter, Sept. 17, 1940.

Miscellaneous Processes

Method of Forming Flat Spiral Tubing. Fig. 7. Patent No. 2,504,426. (Four sheets of drawings.) This invention, made by Albert J. Keyzer of Norwalk, Conn., provides means for making flat spirals of glass tubing for use in gaseous discharge lamps; that is, fluorescent lamps.

The figure shows one form of the invention in which there is an oven 20 heated by burners 20a to soften the tube 21 which is to be formed. A conical spindle 22 is arranged to be turned by a hand wheel 25 so as to wind the soft tube which has been attached to the spindle by a lock pin 28, around the convolutions of the spindle. The tube advances through a guide 34 pivoted at 32 and having the free end in contact with the groove on the spindle so that it acts like a worm and gear following the groove to position the tube therein.

After the conical spiral has hardened, it is put into a flattening device comprising an oven containing a flat supporting disk and a movable upper disk. The cone of tubing is placed on the lower disk and as soon as the glass is soft, the upper disk is lowered to form the tubing into a flat spiral. The patent shows devices for flattening the tube into a non-circular cross-section if desired. There are nine references cited by the patent office.

Machine for Making Bulbs from Tubing. Fig. 8. Patent No. 2,504,817. (Nine sheets of drawings.) Adolph E. Drobish assigned this invention to Western Electric Company, Inc. The machine is particularly adapted to the manufacture of small electric bulbs such as used as signal indicators in telephone systems.

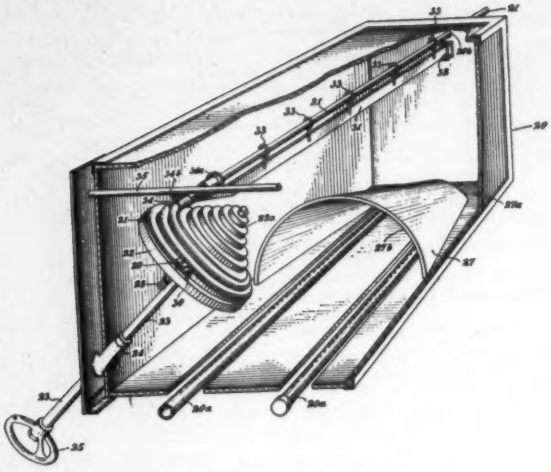


Fig. 7. Method of Forming Flat Spiral Tubing.

No one figure from the patent drawings gives a general idea of the machine, but the figure reproduced here shows a hopper 28 which contains a supply of glass tubes, each of which is long enough to be made into two bulbs. The tubes are delivered to a series of spindles and chucks which are automatically operated so as to grip the tube, heat it and draw it apart so as to form two lamp bulbs. Molds are advanced at the proper time, air pressure and heat are applied to form the bulbs.

The figure shows, along the center line, the various spindles and chucks which form the working instrumentalities and at the lower part of the figure there is seen a row of cams for producing the necessary movements of the working tools.

The following references are of record in the file of this patent: United States Patents: 263,023, Connolly, Aug. 22, 1882; 1,888,851, Donovan et al., Nov. 22, 1932; 2,050,088, Dichter, Aug. 4, 1936; 2,227,224, Kimble et al., Dec. 31, 1940; and 2,406,101, Pipping, Aug. 20, 1946. Foreign Patents: 527,692, Great Britain, Oct. 14, 1940.

Vacuum Tube Machine. Fig. 9. Patent No. 2,504,842. (Two sheets of drawings.) James W. Juvinall and Stanley J. Snorek assigned this invention to Western Electric Company.

The figure shows a stem head 10 positioned in the machine ready to the tubular stem 13 and lead-in-wires 14 fused in place. The machine is intermittently operated and it is of the general type shown in Patent No. 2,063,235 to Charles Eisler. A turret 21 carries several heads, each comprising carriers for the parts to be assembled, these being rotated at each of the dwells except the one where the completed part is removed and new parts placed in position.

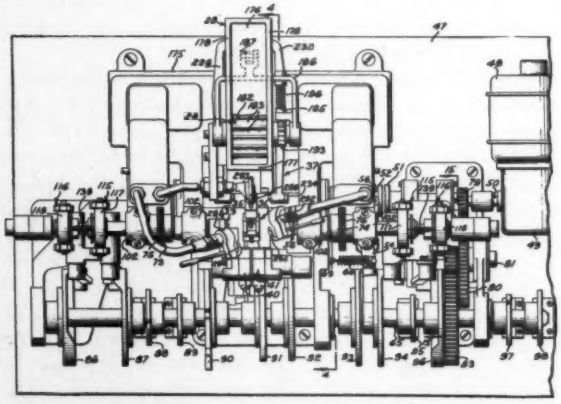


Fig. 8. Machine for Making Bulbs from Tubing.

At the first station after the loading station, the parts are in the position shown in the figure and burners 24 soften the parts to be sealed. At another station the parts are shifted vertically to bring the softened parts into contact and to make the seals. The machine is provided with air pressure to prevent collapse of the parts, and various adjustable and safety features. There are thirteen references cited by the Patent Office.

Circular Fluorescent Lamp Machine. Fig. 10. Patent No. 2,504,938. (Two sheets of drawings.) Gerald S. Quinn and Oliver Mann assigned this invention to Sylvania Electric Products, Inc. The invention is particularly useful in the manufacture of circular fluorescent lamps in which the exhaust tube is sealed into one end of the lamp before it receives its final shape.

The figure shows an exhaust tube 1 extending from the lamp tube 3 in such position that when the single turn helix is flattened into one plane, the exhaust tube will interfere with the other end of the lamp tube. This patent provides a bending jig having a cradle 5 to receive the exhaust tube 1. When the jig is placed in an oven and the glass becomes soft, the weight 8 bends the exhaust tube radially outward so that the glass helix can be flattened into a plane.

The following references are of record in the file of this patent: United States Patents: 2,239,055, Sawyer, Apr. 22, 1941 and 2,265,070, Goode, Dec. 2, 1941.

Method of Making "Thermistors". Fig. 11. Patent No. 2,505,066. (One sheet of drawings.) Assigned to Bell Telephone Laboratories, Inc., by R. L. Rulison, a "ther-

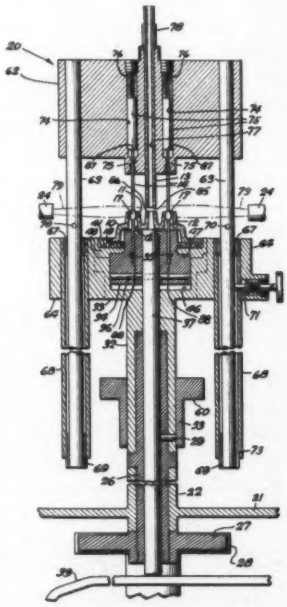


Fig. 9. Vacuum Tube Machine.

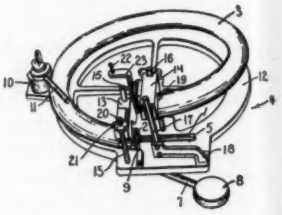


Fig. 10. Circular Fluorescent Lamp Machine.

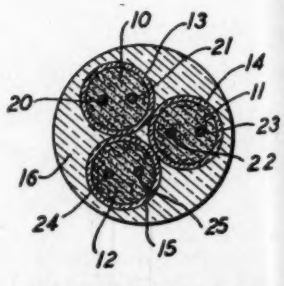


Fig. 11. Method of Making "Thermistors".

mistor" is well known as a resistor which changes resistance greatly in accordance with the temperature. This particular invention shows three thermistors closely associated and enclosed in glass so that the temperature of one affects the others.

The figure is a section through an element having three resistors 10, 11 and 12, each in the form of a bead having two leads closely associated, embedded in insulating material and enclosed by a glass coating 13. The patent gives directions for, first, making the glass coated beads in which the glass melts at about 625°C. and then holding the three beads in a jig where they are enclosed in a glass envelope having a melting temperature of about 500°C. This provides a solid structure in which there is a uniform heat transference.

The following references are of record in the file of this patent: United States Patents: 247,084, Maxim, Sept. 13, 1881; 2,173,906, Katsch. Sept. 26, 1939; 2,212,556, Baier, Aug. 27, 1940; 2,280,257, Pearson, Apr. 21, 1942; 2,339,029, Pearson, Jan. 11, 1944; and 2,391,506, Pearson, Dec. 25, 1945. Foreign Patents: 555,563, Great Britain, Aug. 27, 1943. Other References: Text *"Glass the Miracle Maker,"* Phillips. Published by Pitman Publishing Company, New York. 1941, pages 99-100.

Ampul Opener. Patent No. 2,507,097. Mack R. Fields assigned this invention to Abbott Laboratories of North Chicago, Ill. The patent includes four figures on one sheet of drawings, none of these being reproduced here.

The invention comprises two arms hinged together at one end and normally held open by a spring. One arm carries a file and the other arm has three notches of different sizes so that the neck of an ampul can be inserted in the notch of appropriate size and the arms forced together by hand so as to hold the neck of the ampul against the file. The ampul is then turned to score a line of breakage around the neck.

References cited by the Patent Office were: 849,149, Lybeck, Apr. 2, 1907; 870,951, Goodholm et al., Nov. 12, 1907; 1,169,600, Bastian, Jan. 25, 1916; and 2,410,901, Ramsey, Nov. 12, 1946.

Glass Cutter. Patent No. 2,507,187. This patent, granted to David Terry of Orange, N. J., shows spring actuated wire tongs which are opened by hand and then allowed to close around a circular piece of glass such as the neck of an ampul. One side of the jaws is curved to partially surround the neck of the ampul while the other carries a scratching implement such as tungsten carbide. This is spring pressed against the glass so that as the glass is turned, the neck is scored and it can be easily broken off.

The patent contains one sheet of drawings, none of which are reproduced here. The references cited by the Patent Office were: 454,233, Smith, June 16, 1891; 505,211, Adams, Jr., Sept. 19, 1893; and 1,979,528, Bruce et al., Nov. 6, 1934.

Fire Polishing and Decorating Glassware. Fig. 12. Patent No. 2,507,433. (One sheet of drawings.) Clarence A. Borchert and Robert H. Johnson of Weston, W. Va., made this invention.

According to the specification, the ware to be treated is first cut by hand in the usual manner to produce the design. It is then placed in a heating oven where it is brought up to about 1000°F., and then removed from the oven and placed on a turntable 28 where a heater 31 maintains the temperature of the article. Two or more high temperature torches 32 are moved vertically as the ware revolves so as to fuse the surface of the glass to a depth of less than 0.001 of an inch. Cool air may be applied by the nozzle 33 if desired. After this fire polishing operation, the ware is placed in an annealing lehr which produces an article having a cut design which has been fire polished. There are ten references cited by the Patent Office.

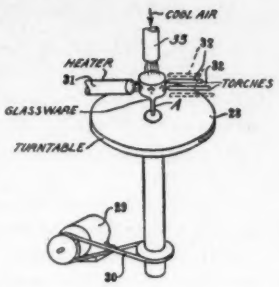


Fig. 12. Fire Polishing and Decorating Glassware.

ELECTRON GUN FOR COLOR TV

When color television comes into common use, weird looking vacuum tubes like the one being held above by S. E. Webber in the General Electric Research Laboratory may come into their own.

An electron beam is fired through the tube and action of the beam on current flowing through the spiral causes a large increase in the power of the current. Color TV will have to be broadcast at very high frequencies over a wide band and this coiled spring in a vacuum, called a "traveling wave tube", is one of the most promising types of tubes for handling these special requirements. The tube would serve as an amplifier in color TV transmitters.

This type of tube was developed during the war by the British for use in radar. General Electric scientists have modified the original designs radically to make the device into a tube capable of remarkably high power output.

CUSTOMS SIMPLIFICATION ACT OF 1950

The stated purpose of this act is "to simplify customs practice" and to remove import restrictions and trade barriers. It consists of twenty-five sections, each dealing with a specific topic. About half of the sections deal with matters of government policy, such as Sections 6, 7, 8 and 12.

The other half of the sections in the act deal with matters which are fundamental to United States Customs policy and administration for more than a century and are important to all manufacturers in this country. Typical of these sections are the following: Sec. 3, "Repeal of special marking requirements"; Sec. 13, "Value"; Sec. 14, "Value not to be based on American selling price"; Sec. 16, "Certified invoices and informal entries"; Sec. 18, "Commingled merchandise"; and Sec. 20, "Conversion of currency". Each of these sections liberalizes or abolishes provisions of existing law which, over a hundred years of experience of customs officials, have been found to be necessary and which have from time to time, at their behest, been enacted into law.

Unlike most legislation which is prompted by changing economic conditions or a political policy, the administrative provisions of the Tariff Act of 1930 are the result of administrative experience which has been found to be necessary with changing times over a long period of years.

The administrative provisions of the Tariff Act of 1930 are not such as can be hastily revised by a committee of alleged experts, but is a matter which would require thorough investigation and study by men experienced in customs before the effects of any change could approach an understanding. Our existing administrative provisions have stood the test of almost a century of litigation and the meaning of their terms is thoroughly understood by those regularly engaged in the business of importing.

"Foreign value" and "export value" have been in the tariff act as a basis for the assessment of ad valorem duty for more than half a century, but even in this day, on the calendar of the United States Customs Court, there are cases involving the application of "foreign value" or "export value". In the existing law there is also a provision for the assessment of ad valorem duties on the basis of the "American selling price". About a quarter of a century ago, Congress found that the then existing forms of value were not adequate to protect certain merchandise because of the ever-increasing spread between cost of production abroad and in the United States. It wrote into the tariff act a provision for the assessment of ad valorem duties on "American selling price" where the other forms of value were inadequate. Provision for its application was made under the "Flexible Tariff", Section 336 of the Tariff Act of 1930.

Under Sections 13 and 14 of the proposed act "foreign value" and "American selling price" are abolished. The other forms of value, although retained in the act, are materially changed. In changing these provisions, customs officials are given the right to estimate, a discretionary power never before conferred upon them. Under the existing law, these provisions contemplate a price to be found under the yardstick provided therein with no room for estimates.

The contents of this act is an attempt to enact into law all of the provisions of the Geneva Trade Agreement and the Havana Charter of I.T.O., which require legislation in order to become effective.

SOLVAY SALES ANNOUNCES PRICE INCREASES

Solvay Sales Division, Allied Chemical & Dye Corporation, has announced an increase of ten cents per 100 pounds of soda ash and fifteen cents per 100 pounds on chlorine and caustic soda in all forms to be effective July 1, 1950.

The new schedules, f.o.b. maker's Works, will be as follows:

	Per 100 lbs.
58% Light Soda Ash in bulk, carloads	$1.10
58% Light Soda Ash in paper, bags, carloads	1.35
58% Light Soda Ash in barrels, carloads	1.85
58% Dense Soda Ash in bulk, carloads	1.20
58% Dense Soda Ash in paper bags, carloads	1.45
58% Dense Soda Ash in barrels, carloads	1.95

	Per 100 lbs.
76% Solid Caustic Soda, in drums, carloads	$3.20
76% Flake, Ground or Powdered Caustic Soda, in drums, carloads	3.60
50% Liquid Caustic Soda, seller's tank cars, basis 76%	2.55
50% Liquid Caustic Soda, Rayon Grade, seller's tank cars, basis 76%	2.65
70-74% Liquid Caustic Soda, seller's tank cars, basis 76%	2.65
70-74% Liquid Caustic Soda, Rayon Grade, seller's tank cars, basis 76%	2.75

	Per 100 lbs.
Liquid Chlorine, single unit tank cars	$2.55
Liquid Chlorine, multiple units, 3 cars (45 tons) or more per year to one destination, contract customer only	3.05
Liquid Chlorine, multiple units, 2 cars (30 tons) per year to one destination, contract customer only	3.65
Liquid Chlorine, multiple units, 1 car (15 tons)	4.25
Liquid Chlorine, multiple units, less than 15 tons per year	4.60

ALL O-C DIRECTORS RE-ELECTED

All directors of Owens-Corning Fiberglas Corp., including Harold Boeschenstein, President and Director since the company's founding in 1938, have been re-elected, according to word from the annual shareholders' meeting in New York City.

Other directors are John E. Bierwirth, New York, President of National Distillers Products Corp.; Frederick M. Eaton, partner in the New York law firm of Shearman, Sterling & Wright; George Keith Funston, president of Trinity College, Hartford, Conn.; James M. Kemper, board chairman of Commerce Trust Co., Kansas City, Mo., and Robert T. Stevens, board chairman of the J. P. Stevens & Co., and also of the Federal Reserve Bank of New York.

GJ Research Digest

Bronze Glass Molds for Pressing Optical Glass Blanks

In a letter to the Editor of the *Journal of the Optical Society of America* (*March, 1950*) Vladimir A. Grodsky describes the use of bronze instead of cast iron for the construction of the molds used for pressing optical glass blanks. Part of this letter is reproduced below for the interest it contains.

All high grade glass parts for Navy optical instruments are melted and pressed in the Glass Division of the National Bureau of Standards. The procedure of forming glass is as follows: Lumps of glass are heated in gas furnaces and after acquiring a pasty consistency are placed into molds set in presses. In order to keep the molds at a more uniform temperature, they are heated by a gas jet. This combination of high temperatures and pressure results in a very severe strain on the metal of the mold.

Cast iron is the material most widely used for glass molds. To increase the heat resistance and strength of the cast iron, it may be alloyed with chromium or nickel and minor quantities of cobalt, molybdenum, vanadium and other elements.

When a charge of hot glass is placed in the iron mold, the surface layers quickly acquire a temperature much higher than the rest of the mold. However, on account of the low heat conductivity of iron, the propagation of heat through the mold is slow, so that different parts of the mold body have very different temperatures. This creates distortion, warping and cracking. The face of the mold becomes soon covered with a network of fine cracks, which increase in size and depth. Graphite flakes exposed to the heat slowly burn out in the presence of air, leaving tiny cavities, and the scale of oxide formed on the iron surface cracks and peels off. Gradually the iron mold loses its smooth surface and the pressed glass becomes rough and opaque, a condition which makes inspection difficult. All this shows that cast iron cannot be considered an ideal material for glass molds.

Several years ago the author greatly improved a bronze covered by Federal Specification for Aluminum Bronze QQ-B-671a. This bronze is an alloy of copper aluminum, iron, manganese and nickel, and has many outstanding properties and can be easily cast, forged, machined, polished and welded. It has good corrosion resistance and a heat conductivity considerably higher than that of iron; also when heated, it is covered with a self-healing protective oxide coating. This bronze was suggested as a material for glass molds and with the encouragement of J. E. Crown and A. J. Devlin, master mechanics of the foundry and optical shop, respectively, glass molds were made from it and tested at the National Bureau of Standards in 1944. The results proved so conclusive that five tons of this bronze were ordered and many cast iron glass molds replaced by bronze-molds. The latter have been in use for five years with excellent results and little need for replacements. Glass pressed in highly polished bronze molds has a good luster and can be readily inspected without additional treatment. As for cost, bronze is more expensive than plain cast iron, but the cost of alloyed cast iron is also high and, besides, its casting and machining are more difficult. Moreover, bronze has always a much higher scrap value than alloyed iron.

JAPANESE GLASS RESEARCH

Editor's Note: During the recent American Ceramic Society meeting, reprints of three Japanese research papers on glass were made available to the Glass Division members. All three papers are from the Asahi Glass Co., Ltd., Yokohama, Japan. Summaries of these three papers follow.

Study on Influence of Alumina Upon Properties of Soda-Lime-Silica Glass

Alumina is used as a component for sheet glass to increase its chemical durability, reduce its devitrification temperature and adjust its viscosity. Yoshiki, Uno and Yoshikawa report on the results of a study of the influence af alumina on these properties. The primary purpose of this study is the determination of the optimum amount of alumina required.

Compositions of glass used were the following four series:

1—$Na_2O{\cdot}0.6\ CaO{\cdot}n\ Al_2O_3{\cdot}5.0\ SiO_2$
2—$Na_2O{\cdot}0.6\ CaO{\cdot}n\ Al_2O_3{\cdot}6.0\ SiO_2$
3—$Na_2O{\cdot}0.8\ CaO{\cdot}n\ Al_2O_3{\cdot}6.0\ SiO_2$
4—$Na_2O{\cdot}1.0\ CaO{\cdot}n\ Al_2O_3{\cdot}6.0\ SiO_2$

with n varying from 0.01 to 0.35 mols.

C. P. raw materials were used and the batches were melted in fire-clay pots at several different melting temperatures.

The chemical durability of the resulting glasses was determined by a powder method in which water at various known temperatures reacted with the glass grains for a three-hour period. The dissolved alkali being determined by titration with N/50 H_2SO_4 using methyl red indicator.

In the devitrification temperature measurement, glass pieces in grain form of about 5mm.^{3} were used as samples. Each one was placed on a platinum plate and put in a platinum electric furnace, which was at a fixed temperature. The samples were held at fixed temperatures for one hour, taken out of the furnace and abruptly cooled after which they were subjected to microscopic examination for presence of crystallization. These operations were repeated at different temperatures (rising) using a fresh sample at each stage and the lowest temperature where no crystallization occurred was determined and designated as the devitrification temperature of the glass.

The results of these tests were given in the form of tables and graphs. In the case of chemical durability, a rectilineal relation was found to exist between logarithm of dissolved alkali and reciprocals of the basolute temperature regardless of the melting temperatures used. In

the case of low alumina glass, the straight line refracts at nearly 55°C., but as the Al_2O_3 increases, the refraction disappears, and glass with about 0.2 mol or more Al_2O_3 shows a straight line. When the water temperature is fixed, the dissolved alkali differs remarkably according to the melting temperature used. High temperature of melting gives more favorable chemical durability. Mol number of added Al_2O_3 and logarithmic values of dissolved alkali have a relationship of a straight line which refracts at near 0.15 — 0.20 mol of Al_2O_3 indicating that the dissolved alkali has an additive relationship to mol number or added Al_2O_3.

In glasses of these series, the addition of Al_2O_3 brings down the devitrification temperature during initial increase of Al_2O_3, but after Al_2O_3 has reached a certain amount, devitrification temperature goes up again. Until the glass becomes a composition of the lowest devitrification temperature, cristobalite is formed, while a composition with more Al_2O_3 generates wollastonite. Although such tendency can be noticed regardless of melting temperature, the curve showing the relation between Al_2O_3 and devitrification temperature differs according to melting temperatures of the glass and within the composition range which forms cristobalite. The devitrification temperature becomes higher when the melting temperature is lower, while in the composition range forming wollastonite, the devitrification temperature becomes lower when the melting temperature is lower.

It was concluded that due to the fact that glasses in these series differ in chemical durability and devitrification temperature according to its melting temperature, it is impossible to determine glass properties primarily by their compositions and that the property improvements can be accomplished to a certain degree by varying the added amount of Al_2O_3 in low melting temperatures which were heretofore expected by high temperature melting.

Study on Composition of Low Alkali Glasses

For the manufacture of chemical ware, such as ampul or gauge glass, which calls for a glass of high chemical durability, borosilicate glass is generally used. As Japan lacks boron resources, this research work was performed by B. Yoshiki and R. Yoshida with a view towards producing a chemical ware glass containing no boron and as little soda as possible.

This research adopted a melting diagram method for the derivation of a new glass composition. Silicate compounds with chemical ingredients necessary for glass forming were selected and a melting diagram of a system consisting of such silicates was experimentally obtained in order to determine the new glass composition which was to have a low melting temperature and stable workability. Fortunately, the new glass composition obtained by this work contains little alkali and much alumina, so that natural resources of silicate rocks can be conveniently used as raw materials.

In the development of the diagrams, three silicates (natural or artificial) were used; namely, albite, diopside and wollastonite, and their ternary melting diagram was studied. The measurement of melting temperature of each mixture was made by the quenching method in which about 20 grams of the sample contained in a platinum vessel was kept at several constant temperatures for 30 minutes and after that, the temperature at which the quenched sample became all glass under the microscope was determined to be its melting point. A mixture having the following chemical composition: SiO_2 60-67%; Al_2O_3 10-15%; CaO 7-15%; MgO 2-5%; and Na_2O 5-8% was found to have the proper melting temperature and necessary viscosity for commercial production.

A practical melting test was then made using a batch of the following composition: SiO_2 65%, Al_2O_3 13%, CaO 11%, MgO 4% and Na_2O 7%. Natural rocks, which included perlite, trachyte, kali-liparite and albitite, were used as the main raw materials. Physical properties such as melting temperature, fining temperature, working properties, devitrification temperature, softening temperature, annealing temperature, specific gravity, coefficient of expansion, mean specific heat, thermal endurance and chemical durability were measured and were found to compare favorably with the usual borosilicate glasses. This practical melting test showed that the best workable glass was obtained with the natural rock, albitite (chemical composition: SiO_2 63.83%, Al_2O_3 21.94%, Fe_2O_3 0.34%, CaO 3.63%, MgO trace, K_2O 0.09%, Na_2O 10.21% and ignition loss 0.69%).

As a result of this research, production of a desired glass on an industrial scale has been accomplished without using soda ash at all and by utilizing natural rocks which have been unexploited resources.

On High Temperature Modifiention of Barium Feldspar

High barium optical glass, such as dense crown glass, brings a very remarkable corrosion against the clay pot in which it is melted, so that the influence of such corrosion upon the quality of the obtained glass must not be overlooked. When the melting operation has proceeded satisfactorily and entailed no conspicuous corrosion, inspection of the pot shows a coating layer consisting of crystallized material formed on the inside of the pot. Microscopic examination of this layer revealed that the crystallized substances were barium feldspar (celsian) and presumably had been formed as a result of high temperature reaction between the clay materials constituting the pot and the barium oxide in the glass. From this fact it was concluded that corrosion by the glass might be prevented by previously giving the pot a lining with artificial barium feldspar.

In the course of an examination of synthetic barium feldspar by Yoshiki and Matsumoto, conclusive data on the existence of a different modification of this compound was obtained.

Excellent crystals were synthesized and used for clarification of crystallographic properties, crystalline structure and thermal properties, with a result that a phase relation was found to exist in this compound with a close similarity to those in silica minerals. Proof was made of the existence of hexagonal modification for the high temperature form, against monoclinic celsian for the low temperature form and also the existence of $\alpha \rightleftarrows B$ inversion in the latter at near 300°C.

• Thatcher Glass Manufacturing Company, Inc., has declared a dividend of $.10 per share on its common stock.

A.C.S. CAMERA CLUB AWARDS AND ELECTION OF OFFICERS

At the 11th Annual Meeting of the American Ceramic Society Camera Club held during the Society's recent annual meeting, the following awards were announced: *American Ceramic Society Awards,* 1st Prize, $25.00 to Ed Immer; 2nd Prize, $15.00 to John Kalinich; and 3rd Prize, $10.00 to Vic Remington. *Frazier Award,* George C. Hagenbottom. *Vontury Award,* to John Kelinich. *Mexican Award,* John Kalinich. *Seader Award,* Hobart M. Kraner. *Walter Gitter Award,* John Nevius. *Pictorial Ribbon Awards,* 1st Place to George C. Hagenbottom; Honorable Mention to Charles Bates. *Industrial Ribbon Awards,* 1st Place to Ed Immer; Honorable Mention to John Kalinich. *Color Ribbon Awards,* 1st Place to Hobart M. Kraner; 2nd Place to John Nevius; Honorable Mention to Hobart M. Kraner, A. Josephine Gitter, and Franz Schwalbe.

Following the announcement of the awards, Hugh Kline of Corhart Refractories Company reviewed the activities of the Camera Club during the year and expressed his appreciation for the interest shown in the Club, the entries submitted and the qualities of the prints and transparencies.

Election of officers for 1950-51 term was held with the following results: Chairman, W. Wallace Rott; Secretary and Treasurer, D. P. Falconer; Board of Control, Hugh Kline, George C. Hagenbottom, Ed Immer and Henry Walker.

F. M. JENIFER, PCB PRESIDENT, DIES

F. M. Jenifer, President of the Pacific Coast Borax Co., Division of Borax Consolidated, Ltd., died on May 25 at his home in Los Angeles.

Born in 1878, Mr. Jenifer started work with the railroads and in November 1907, was sent to Goldfield, Nevada, as the Nevada General Agent for the Tonopah and Tidewater Railroads. He continued in this capacity until he was made President and Treasurer.

In 1926, he became assistant general manager of the Pacific Coast Borax Company. He became President of the firm in 1937 which position he held until his recent death. He was also Vice President of the U. S. Potash Company and was active in civic affairs. He was a Past President of the Jonathan Club and was active in the Los Angeles Country Club.

Mr. Jenifer is survived by his widow, Sarah E., two brothers, James and Jack, and one sister, Mrs. Otis.

DUNCAN AND MILLER APPOINTS REPRESENTATIVES

Announcement has been made by the Duncan and Miller Glass Company of the appointment of Karl Knoblauch of Minneapolis and Maurice H. Brahl of St. Louis as representatives. Both men have had long experience in the glass and china industry.

Mr. Knoblauch's territory will include the states of Minnesota, North and South Dakota, Iowa and Nebraska, the upper peninsula of Michigan, and all of Wisconsin except Milwaukee, Racine and Kenosha.

Mr. Brahl will represent Duncan and Miller in Illinois, with the exception of Chicago, and all of Missouri, except Kansas City and certain portions of St. Louis.

NEW CHEMICAL COMPANY FORMED

John B. Caldwell, formerly Vice President and General Manager of Merchants Chemical Company, Inc., has announced the formation of a new company for the sale and distribution of industrial chemicals, Caldwell Chemical Company, Inc. The new firm's main offices are located at 220 East 42nd Street, New York 17, New York.

A branch office has been set up at 2049 East Grand Boulevard, Detroit, Michigan, with George L. Brown as Manager.

Mr. Caldwell, who left Merchants Chemical Company recently, started with that company in 1945 when he opened their Detroit office and served as Manager. He was brought to New York two years later where he was made Vice President and General Manager of the firm. Before going with Merchants Chemical, Mr. Caldwell spent four years as Liaison Engineer with General Motors Company.

GLASS COMPANIES FILE SUIT AGAINST GAS COMPANY

Five eastern Oklahoma glass companies filed suits March 31 to abolish "priority" rates of the Oklahoma Natural Gas Company. The joint suit asks court action to provide that "in the furnishing of natural gas to industrial users, the Oklahoma Natural Gas shall give no priority or preference right to purchase gas because one or more industrial users offer to pay a greater sum than is fixed for those who have not contracted for such priority service".

The companies seek an order compelling ONG to "furnish to the plaintiffs without discrimination natural gas in such quantities as will meet their needs". Attorneys for the glass companies contend that some industrial users of gas are forced to curtail operations during certain seasons because gas is allocated to those who have signed a "priority" agreement.

Companies filing the suit are Bartlett-Collins of Sapulpa, Alexander H. Kerr Co., of Sand Springs, Brockway Glass Co., Muskogee, American Window Glass Company, Okmulgee, and Pittsburgh Plate Glass Co., Henryetta. Hearings in the case will be some time in April.

LACLEDE-CHRISTY ACQUIRES ILLINOIS FIRM

Donald N. Watkins, President, has announced that Laclede-Christy Company has entered into an agreement to acquire the assets and liabilities of the Chicago Retort and Fire Brick Company of Ottawa, Illinois, in exchange for common stock.

The Chicago Retort and Fire Brick Company was organized in 1887 and since then has been continuously engaged in the manufacture and sale of fire brick and high temperature cements. It operates a large plant at Ottawa, Illinois, which has recently been completely modernized including the construction of a new tunnel kiln unit.

SYLVANIA ELECTS NEW BOARD CHAIRMAN

At a meeting of the Board of Directors of Sylvania Electric Products, Inc., Max F. Balcom was elected Chairman of the Board to succeed the late Walter E. Poor, and Frank A. Poor, founder of the company, was elected Vice-chairman.

Three new directors were elected and they are Edward J. Poor, who resigned as Chairman in 1943; Richard L. Bowditch, President of C. H. Sprague & Co.; and H. Ward Zimmer, Vice President in charge of Operations.

Mr. Balcom, the new Board Chairman, has been associated with Sylvania since 1918 when he became purchasing agent for a predecessor company, Novelty Incandescent Lamp Co., in Emporium, Pa. In 1931, with the formation of Hygrade Sylvania Corporation, he was made assistant secretary of the new organization and placed in charge of radio costs and general corporate work. He became a director in 1934. Three years later, he was elected Vice President in charge of the Radio Division and in 1944 was elected Treasurer.

At the company's stockholder meeting, Don G. Mitchell, President of Sylvania, announced that first quarter sales and earnings were the best the company had ever enjoyed in any peace-time initial quarter. Sales of $29,347,911 compare with $27,108,895 in the first quarter of 1949. Earnings of $1,225,844 were equal to 77 cents per share on the company outstanding common stock after dividends per share on the $4 cumulative preferred stock. This compared with earnings of $1,176,815 and 74 cents per share in the same period last year.

FREIGHT DECISION

The U. S. Court of Appeals at Chicago recently handed down a decision of unusual importance to shippers and receivers of freight.

The Court held that where a railroad company has actual knowledge of loss and damage to a shipment, it is unnecessary for a shipper to file written notice of claim within nine months after failure to deliver property, in accordance with the Bill of Lading. It also held that actual knowledge by a carrier as a substitute for written notice is not a discrimination or preference in favor of a particular shipper.

CANADIAN FLAT GLASS TRIAL POSTPONED

Trial of the nine Ontario and Quebec flat glass companies charged with operating a combine, scheduled to open in Toronto, Canada, on June 6, was postponed until Sept. 5, with Chief Justice McRuer granting the adjournment at request of the companies who claim they will need more time to prepare their defense.

Some 1,500 documents are expected to be submitted at the trial which will last at least three weeks.

NEW OPTICAL GLASS DEVELOPED AT NORTHWESTERN UNIVERSITY

Dr. Rudolph Frerichs, Northwestern University physicist, has developed an arsenic sulfide glass of high transmission in the infrared which can be molded easily.

Glasses having transmission in the infrared beyond 5 microns are of great value in infrared spectography and "night seeing" instruments which form an image from infrared radiation and convert it to the visible range by means of fluorescent screens. Dr. Frerichs' glass is characterized by a high refractive index also.

The more common oxide glasses (silicates, phosphates, borates, germaniates) are limited to transmissions below five microns. The greatest transmission in the infrared near five microns is found in high lead, low silicon glasses.

The National Bureau of Standards has investigated optimum conditions in oxide glasses and developed antimoniate and aluminate glasses having transmissions beyond six microns.

As the need for glasses free of oxygen was recognized, the development was found restricted by manufacturing and service problems.

Among the non-oxide glasses described by early investigators, in particular G. Tamman, are sulfide glasses, such as the vitreous forms of germanium sulfide, tin sulfide, arsenic sulfide and antimony sulfide. According to W. A. Weyl, who explained the formation of these glasses by the pairing of S^{2-}, an ion of greater polarizability than oxygen, with cations larger and weaker than Si^{4+}, the earlier glasses could be expanded by the use of titanium and other cations larger than silicon as well as of Se^{2-} and Te^{2-} in conjunction with or in the place of S^{2-}. Thallous telluride, for instance, has been reported to form a glass.

In Dr. Frerichs' new infrared transmitting glass, arsenic sulfide was selected as the most suitable compound.

BROCKWAY ACQUIRES MIDWEST GLASS PLANT

Glenn A. Mengle, President of Brockway Glass Company, Inc., has announced that his company has purchased the idle glass plant of Sterling Glass Division, Warfield Company, at Lapel, Indiana, and after engineering studies had been completed, plan to modernize, expand and equip the plant with the most up-to-date high-speed glass container machinery. Construction work is to be completed in order that operation begin early in 1951.

The Warfield Company recently shut down its Lapel plant and advised its customers and employees that it had gone out of the glass container business. The acquisition of this plant by Brockway will enable the firm to give more direct service to the Middle West—Chicago, Indianapolis, Milwaukee, St. Louis, Cincinnati, Detroit, and Louisville areas. Mr. Mengle stated that the cost of the modernization of the Lapel plant would be approximately $1,850,000.

• R. R. Underwood, President of Knox Glass Associates, Inc., and the Knox Group of Companies, was elected a director of the Buffalo, Rochester and Pittsburgh Railway at the annual meeting of stockholders. Mr. Underwood fills the vacancy created by the death of The Honorable Daniel J. Kenefick of Buffalo, New York.

CURRENT STATISTICAL POSITION OF GLASS

Employment and payrolls: During the month of March, 1950, employment in the glass industry reached a total of 108,900. This is only about .005 per cent higher than the 108,200 persons employed during February 1950.

Payrolls in the glass industry during March 1950 have been reported at a preliminary $27,884,571. During February, payrolls were an adjusted $27,766,284. This represents only a slight increase for March over February.

Glass container production, based on figures released by the Bureau of Census, continued upward for April 1950 to reach 8,420,481 gross. This is 2½ per cent more than for March, which was 8,203,935 gross. During April 1949, container production had been reported at 7,035,075 gross, or 19½ per cent below April this year. Total glass container production at the close of the first four months of 1950 has reached 31,908,484 gross. This is a little more than 13 per cent above the 28,150,757 gross produced during the same period in 1949.

Glass container shipments for April 1950 fell off about 5½ per cent to reach 7,879,163 gross. This is a decrease from the 8,312,654 gross shipped during March 1950. April 1950 shipments, however, represent an increase of slightly more than 11½ per cent over the corresponding month's shipments in 1949, which were 7,050,577 gross. Container shipments for the first four months of 1950 continue to be ahead of the corresponding period in 1949. The 1950 January-April figure has now reached 30,681,538 gross. This is 14½ per cent above the 26,772,818 gross shipped at the close of the January-April 1949 period.

Stocks on hand at the close of April rose to 10,006,167 gross from the 9,453,749 gross on hand at the close of March. Stocks on hand at the close of April 1949 were 9,763,334 gross.

Automatic tumbler production for April 1950 was 6,515,398 dozens. This represents a 7½ per cent increase over the previous month's 6,060,658 dozens produced. During April 1949, production was 4,620,563 dozens. Shipments of automatic tumblers for April 1950 fell off a little more than 1 per cent from the 6,250,865 dozens shipped during March to 6,167,764 dozens. Shipments during April 1949 were 4,904,746 dozens. At the close of April 1950, stocks on hand were 9,937,696 dozens, or 3 per cent more than the 9,642,489 dozens on hand at the end of March. There were 8,270,234 dozens on hand at the close of April 1949.

Table, kitchen and household glassware: Manufacturers' sales of automatic table, kitchen and household glassware dropped 16 per cent for April 1950 to reach 3,265,924 dozens. This is below the 3,900,264 dozens sold during March 1950. Sales during April 1949 were 2,263,948 dozens. Manufacturers' sales at the close of the 12-month period ending April 1950 now total 39,293,995 dozens. This is close to 1½ per cent below the 39,892,581 dozens sold at the close of the same period in 1949.

GLASS CONTAINER SHIPMENTS
(All figures in Gross)

	April 1950
Narrow Neck Containers	
Foods	875,860
Medicinal & Health Supplies	1,018,121
Chemicals, Household & Industrial	511,173
Beverages, Returnable	584,470
Beverages, Non-returnable	7,849
Beer, Returnable	239,383
Beer, Non-returnable	236,059
Liquors	638,688
Wines	325,371
Toiletries & Cosmetics	434,166
Sub-total (Narrow)	4,871,140
Wide Mouth Containers	
Foods	1,738,970
Dairy Products	227,960
Home Canning	154,162
Medicinal & Health Supplies	281,434
Chemicals, Household & Industrial	121,343
Toiletries & Cosmetics	121,862
Packers' Tumblers	131,988
Sub-total (Wide)	2,777,719
Total Domestic	7,648,859
Export Shipments	230,304
Total Shipments	7,879,163

GLASS CONTAINER PRODUCTION AND INVENTORY
(All figures in Gross)

		Production April 1950	Stocks April 1950
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	3,184,347	3,588,431
	Wide Mouth	2,488,031	2,563,967
Dairy Products		217,658	306,663
Home Canning		109,674	611,533
Beverages, Returnable		713,768	1,032,403
Beverages, Non-returnable		5,432	32,450
Beer, Returnable		276,481	541,920
Beer, Non-returnable		251,112	293,346
Liquors		722,366	627,964
Wines		321,349	290,282
Packers' Tumblers		130,233	117,248
Total		8,420,481	10,006,167

LYNCH ADDS TO ENGINEERING STAFF

It has been announced by Lynch Corporation that Harold A. Youkers has joined the Engineering Department of the firm's Glass Machinery Division.

Prior to his present connection, Mr. Youkers worked from 1933 to 1938 for Chicago Pneumatic Tool Company. In this position, he did experimental work on engines and compressors, as well as engineering design.

From 1938 to 1950, Mr. Youkers was employed as an engineer for the Knox Glass Associates. When he left Knox, he was General Fabrications Engineer specializing on mold development and machinery design and test.

NEW EQUIPMENT AND SUPPLIES

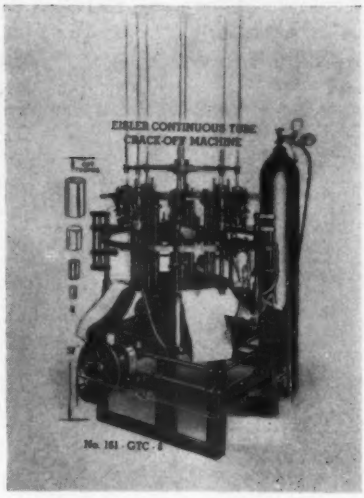
THREE TYPES OF POLARIMETERS

The Polarizing Instrument Company, Inc., Mount Kisco, New York, has made available three types of Polarimeters for the measurement of strain in glass. The instrument will measure the effect of residual annealing stress on transmitted polarized light with greater sensitivity than is possible through other means, such as a petrographic microscope in combination with a quartz wedge or a Babinet compensator.

The Polarizing company's Polarimeter Model 201 is a modification of the photo-elastic polariscope with changes adapting it to problems in the study of glass. Having a 4½" aperture, it is mounted in a fixed position with the polarizing axis at 45°. The stage, 4" x 6", is adjustable in a vertical direction. The quarter wave compensator is set at a fixed angle and it is mounted on the same stand as the analyzer which rotates from 0° to 180° clockwise and from 0° to 180° counterclockwise.

Polarimeter No. 202 combines the features of a polariscope, since it shows strain qualitatively in color; a comparator, since it compares the image of the specimen on the screen with several known values shown in color in six "windows"; and a polarimeter, since it evaluates the strain shown on the screen. This instrument has a white light source and the optical path is 1½" in cross-section diameter. At the right of the stage is the knurled handle of a lever. With the handle in the back position, the optical path contains a first order red sensitive tint plate and the color of the screen is the typical violet-red. Moving the handle forward, the sensitive tint plate swings out of the optical path and, in the same motion, a quarter wave compensator swings into place in the optical path and the screen becomes black. Its six windows are frames for standard 3¼" x 4" slides. The range of the rack and pinion focusing is about one inch up above the stage, which is 7" x 9".

Polarimeter No. 203 has a dual light source white light for qualitative examination and monochromatic light for quantitative measurement. The change from white light to monochromatic is made by pressing a plunger. The specimen stage is movable both vertically and transversely and such movements can be read on a dial knob down to 0.01". The optical system is a dual type mounted on a turret. Any part of the specimen which warrants quantitative measurement is centered with reference to the optical path by the movement of the specimen stage. For those who require even greater accuracy, the firm will design the instrument so that the vernier division will provide a precision down to 0.01° to 0.030 mμ.



NEW TUBE CRACK-OFF MACHINE

Eisler Engineering Co., Inc., 750 South 13th Street, Newark 3, New Jersey, has recently placed on the market a motor-driven automatic crack-off machine developed for uniform and increased output.

The operation of the machine is principally based on creating a strained section on the tubing where the severed end is required. By passing of the glass through an intensive gas-oxygen fire and followed with touching of the heated section by a cold steel disc, complete cracking-off of the predetermined length of the tubing will be effected.

The machine is designed for cutting glass tubing from a five-foot length to the required length ranging from ⅛" to 4". The tube-holding chuck can be supplied in ranges from 3-15, 8-18, 10-22, or up to 30 millimeters. The output of the machine is approximately 3,000 to 4,000 pieces per hour, depending upon diameter and wall thickness of the tubing. Only one operator is required to attend two or three machines. For increased production, the model is available with 10 or 12 heads.

MASONRY CUTTING IMPROVEMENT

Clipper Manufacturing Co., 2800 Warwick Trafficway, Kansas City 8, Missouri, has announced the development of a wet or dry pump for application on its Model HD Clipper masonry saw which eliminates the necessity of disconnecting the pump when cutting dry.

To switch from wet to dry cutting, the operator turns the pet cock on the outlet of the pump. The new factory-sealed pump cannot be damaged by dry cutting. There is no need to remove the V-belts.

CATALOGUES RECEIVED

Frazier-Simplex, Inc., Washington, Pa., has released a new 20-page catalogue featuring Simplex lehrs.

Entitled "Simplex Lehrs Cut Production Costs", the catalogue is fully illustrated with descriptive photographs. It shows how Frazier-Simplex cuts production costs with modern machinery.

Sections of the catalogue are devoted to the semi-muffle annealing lehr, full muffle annealing lehr, electric lehrs, radio and television specialized equipment, and decorating lehrs.

Barber-Green Company, Aurora, Illinois, has published a new 40-page catalogue on its Redi-Fab Series of belt conveyors.

In cases where the user wishes to make his own selection, the new catalogue lets him select the conveyor for his own particular needs without requiring technical knowledge. For example: the horsepower of the motor and the horsepower of the drive is automatically correct without any calculation.

One of the features of the catalogue is the Redi-Fab Conveyor Layout Sheet, which makes it easy for the user to make his own layout right down to the location and selection of supports.

Walsh Refractories Corporation, Dept. W., 101 Ferry Street, St. Louis 7, Mo., has released a new bulletin featuring Warco brand intermediate duty and high heat duty fire brick. The properties are detailed and general characteristics and uses are specified.

Information on the facilities of the organization for the production of special fire clay shapes to meet practically every requirement is included, as well as data on other related products.

Hagan Corporation, 323 Fourth Avenue, Pittsburgh, Pa., has issued a booklet describing its meter type differential master sender.

The master sender, which is used as the metering element in the measurement and control of steam, gas and liquid flow, liquid level, pressure differential and similar applications, is described and illustrated in this new Bulletin 2150. Applications are given with information about the machine's construction features and its operating characteristics.

Mississippi Glass Company, 88 Angelica Street, St. Louis 7, Mo., has issued a new consumer booklet, "Modernize Your Home with Decorative Glass".

The booklet shows actual photographs of installations of Mississippi glass in the home. Designed as an idea book, it demonstrates how structural corrugated glass and other patterns can be employed in the home.

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4. Higher softening point (P. C. E. value of Cone 36 . . . 3290 deg. F.)
5. Vacuum Cast (for greater resistance to severe service conditions)

873 calendar days . . . nearly 29 months of continuous operation (and only then out of service due to fuel shortage) is the record established in this large, flat glass furnace melting soda lime glass. Walsh Cast-Flux, Vacuum Cast Tank Blocks in the sidewalls and bottom, with C. S. R., Cast Sillimanite Refractory Upperstructure, provide the winning combination responsible for this record of maximum service life at *lowest* cost.

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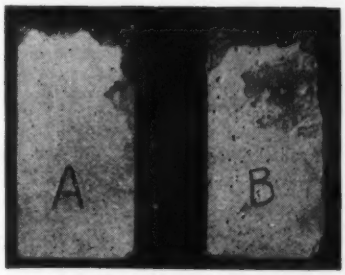

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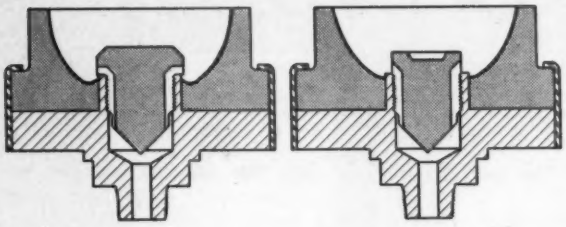
(*Continued from page* 299)



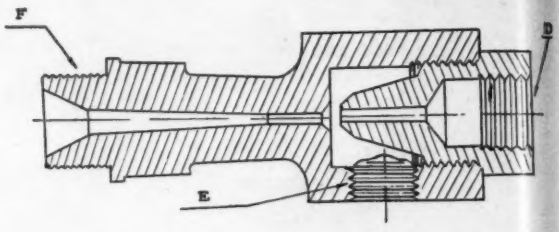
TYPICAL SECTION SHOWING CUP CONTOUR AND TIP FOR NATURAL GAS, PROPANE AND BUTANE.

TYPICAL SECTION SHOWING CUP CONTOUR AND TIP FOR MANUFACTURED GAS.

Figure 10.

Fig. 11. Radiant cup burner.

Fig. 12. F, gas-air combustion mixture exit to burner; E, gas inlet; D, air inlet.



out cannot be overcome, it is advisable to install storage tanks that may be filled during the night and drawn from during the working day.

Sulphur content of the natural gas (the sulphur content of manufactured gas of around 7-10 grains per 100 cu. ft.) has been found to serve as a lubricant when making flares. See Fig. 2(2). When blowing miniature bulbs, the molds also require similar lubrication.

When using natural gas without this sulphur, two means of supplying the deficiency are in use: the first is vaporization of carbon disulphide (CS^2) into gas at the flaring pin position.

The second is the addition of sulphur dioxide (SO^2) gas by the vaporization of liquid SO^2 into the gas system. An automatic system of this type is available. The use of SO^2 in the atmosphere of lehrs is known to increase the glass strength. A too excessive use is to be avoided, so automatic control is needed. The addition of sulphur compounds to the natural gas must be done only at the fire (burner) positions where necessary since the absence of sulphur compounds is advantageous where nickel leads are involved in stem making. A small percentage of sulphur will cause objectionable embrittlement in pure nickel leads.

Venturi Mixer

All glass working flames are mixtures of gas and air or oxygen. The proper mixing of these two to get the right gas burning mixture is of extreme importance. Of several ways to do this mixing, the two pipe system using Venturi mixers is the most used. Such a mixer is shown in section in Fig. 12.

The preferred pressures are gas at about 18" wc and air at 4 psi. It has been found that these mixers must be more accurately tailored to the job in natural gas work than with manufactured gas.

Valves. To assist the firesetter in overcoming the higher B.T.U. values of natural gas and help in the finer control needed, the gas and air valves should have finer stem threads than required with manufactured gas. In natural gas work it is customary to use a 32 or 40 threads per inch stem instead of the older 16-thread type or typical hose cocks.

Use of Oxygen Gas Fires

Ordinarily no trouble is experienced when an oxygen gas job is changed from manufactured to natural gas. In fact, the change is usually beneficial for the oxygen-natural gas flame is hotter than the oxygen-manufactured gas flame, i.e. 5135°F. vs. 5050°F. It is to be noted as in a preceding paragraph that some more oxygen per B.T.U. may be required for the natural gas than for the manufactured gas.

Summary

In the foregoing discussion, the factors needing attention when the gas supply is changed from manufactured gas to natural gas are given. However, in many instances where the operation uses the full flame temperature of the manufactured gas-air mixture, it will be necessary to add some oxygen to the natural gas-air mixture to keep up the production rate. This addition of oxygen accomplishes two things: (1) increases the effective flame temperature, and (2) shortens the focal length of the flame.

In installations where the sendout is a mixture of manufactured gas and natural gas with or without reforming, the troubles of the full substitution will be encountered but in a lesser degree. These troubles will be in proportion to the reduction in the percentage of hydrogen and the increase in the percentage of methane in the sendout gas. The reduction in hydrogen and increase in methane both work the same way, i.e. to reduce the flame temperature and increase the focal length of the flame. The effect of these two components can be seen from their characteristics in Table 5.

TABLE 5

Gas	*Maximum flame speed feet per second*	*Maximum flame temperature gas-air mixture*
Hydrogen	9.2	3713° F.
Methane	.85	3416° F.

When using gases of 530 B.T.U., 600 B.T.U. or 800 B.T.U., both flame temperature and flame length troubles show up. It is therefore wise to change burners to those found best for straight natural gas. Burners designed for straight natural gas burn well on any of the mixtures, giving greater B.T.U. release. Only one difficulty arises: if burned at low rates or with gas rich flames, the pilot

(*Continued on page* 324)

SETTING A LACLEDE-CHRISTY POT AT CAMBRIDGE GLASS COMPANY

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BURNER EQUIPMENT . . .

(*Continued from page* 322)

areas are very likely to burn a bright red and require early replacement.

Bibliography

A few present day articles on this subject follow.

Atmospheric Burner:

American Gas Association (A.G.A.) Publications
Research Bulletin No. 10—Research in Fundamentals of Atmospheric Gas Burner Design
Research Bulletin No. 13—Fundamentals of Design of Atmospheric Gas Burner Ports

These bulletins give fundamentals and examples covering the design of household burners. The data is applicable to all open flame drilled port burners used in glass forming for both natural and manufactured gases.

Bunsen and Meeker Burners:

"A Study of Laboratory Burners for Natural Gas" by John H. Eiseman, Journal of Research, National Bureau of Standards, Vol. 42; pp 541-556 (R.P. 1991) June 1948 covers the proper design of Bunsen and Meeker burners and must be followed to obtain maximum efficiency from natural gas burners.

Glass Blower Torches or Nozzle Mixing Burners:

"Scientific Glass Blowing and Laboratory Techniques" by W. E. Barr and V. J. Anhorn, Instruments Vol. 18, pp 875-878, Dec. 1945. A very interesting treatment of the subject but could expand the references to natural gas.

Glass Lamp Assembly Machine Burners:

"Burners for Lamp Working" by H. K. Richardson, Industrial Gas, Vol. 27 (10) pp 8-11, 22-24 is a report of a talk given to Glass Division, American Ceramic Society at Bedford Springs, Oct. 9, 1948.

"Gas change may require unusual skill to effect utilization. Glass working units point up the problem". H. K. Richardson, American Gas Journal, Oct. 1949.

The first reference gives details of the factors governing the design for fine burners for use with both natural and manufactured gas, and the second reference discusses the factors to be considered in changing from manufactured to natural gas in a lamp working factory.

Ceramic Burners:

"Radiant Heating" in Glass Working Production and Equipment" H. K. Richardson. Bulletin, American Ceramics Society, Vol. 29 (1) pp 20-26, Jan. 1950. This covers talk given to Glass Division of A.C.S. at Cincinnati meeting April 25, 1949. A wide range of application of radiant heating by ceramic burners to glass working problems is covered both theoretically and practically.

Combustion Control of Gas Mixtures:

"Gas Combustion Equipment," Steel, Sept. 22, 1947, D. A. Campbell. The six customarily used systems for mixing gas and air for burning gas properly are discussed together with equipment. This should be read by everyone interested in the best combustion control of gas-air burners or equipment.

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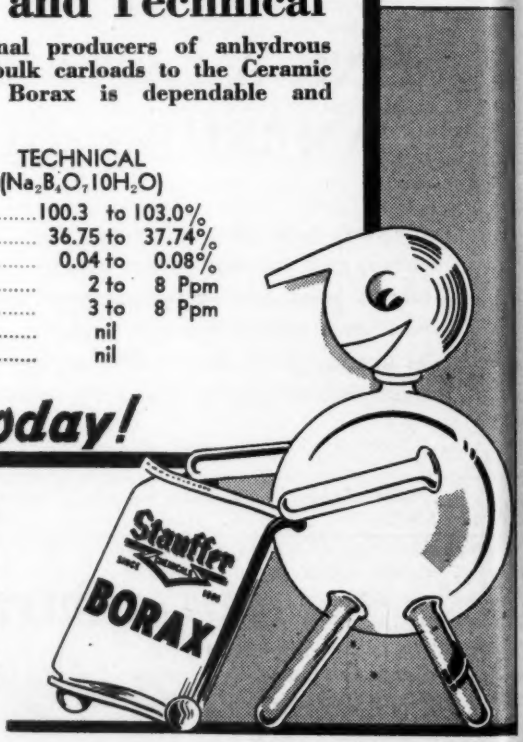
Sodium Borate	99.25 to 99.50%	100.3 to 103.0%
Boron as B_2O_3	68.00 to 68.89%	36.75 to 37.74%
Chlorides as NaCl	0.10 to 0.16%	0.04 to 0.08%
Iron as Fe	30 to 35 Ppm	2 to 8 Ppm
Arsenic as As_2O_3	20 to 40 Ppm	3 to 8 Ppm
Sulphates as Na_2SO_4	0.3 to 0.4%	nil
Carbonates as Na_2CO_3	nil	nil



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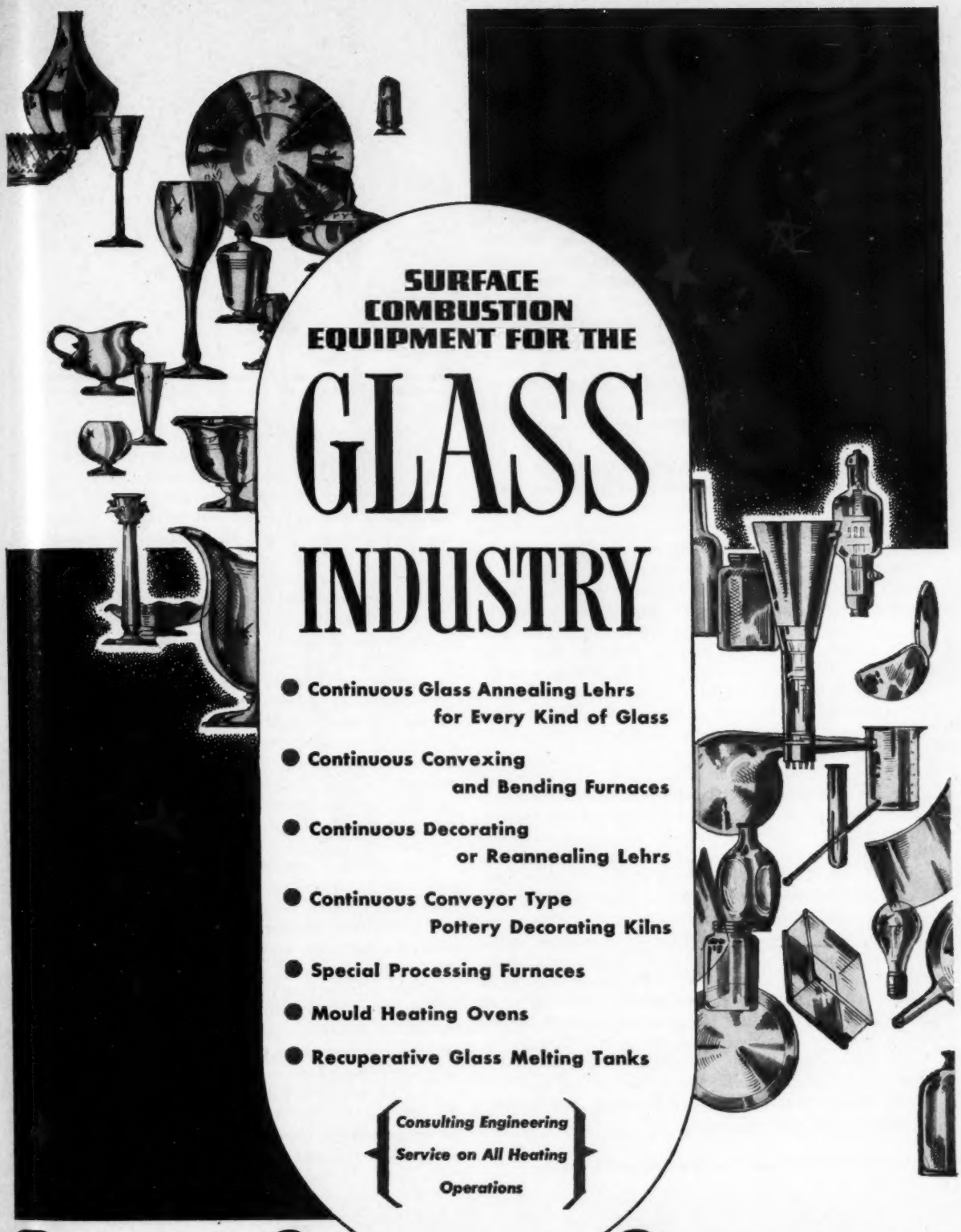

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(*Continued from page* 307)

tion of one form into another is very difficult. Most changes in modification as well as crystallization from the melt represent sluggish processes. As all silicates follow the same principles, it is only reasonable to assume that they hold true for vitreous silicates also. The first thoughts on the structure of glass were, therefore, directed by these principles, and all pictures had to be discarded which did not agree with the laws governing the structure of crystalline silicates. The co-ordination number of the ions in glasses should be about the same as that in the crystalline state, for a change in co-ordination means a strong change in the energy content. The relative stability of commercial glasses can be explained only by the ions having a co-ordination similar to that in crystals. W. H. Zachariasen and B. E. Warren have discussed possible structures for vitreous silica and simple glasses which were based on the principles of crystal structure.

"In the crystal, the position of the atoms can be defined, in any co-ordination system, and it does not matter where we place the origin of the system. In liquids, such a method cannot be used: P. Debye, however, showed that liquids also have a certain regularity in their atomic arrangements. In order to detect this regularity, we have to use a system of co-ordination the origin of which moves with one of the atoms. In other words, the origin has to be in the centre of one atom and follow its thermal motions. It is obvious that in this case we shall not find atoms which are closer to the origin than the diameter of the atom itself. On the other hand, at this distance we have to expect quite a number of atoms. The distance corresponding to twice the atomic diameter is preferred in a similar way, but not as pronounced as the first.

"These considerations have already led to the conception that atoms in liquids must assume a certain regularity in their arrangement. The chief difference between the structure of a liquid and of a glass consists in the fact that in liquids the neighbors of each atom are changing constantly, whereas in a glass each atom finds itself surrounded by a number of other atoms at approximately defined distances."

We have, so far, only considered the immediate neighborhood of different ions. The chief characteristic of all crystals is the strict three-dimensional periodicity with which a given spacial arrangement of a few atoms or ions, called the unit cell, is repeated to build up the whole crystal. This also forms the chief difference between crystals and the corresponding glasses and glazes. The immediate surroundings of any given ion are very similar or identical, but the three-dimensional periodicity is lacking in glasses and glazes.

Atomic Arrangement in Glasses and Glazes

On the basis of his studies of crystal chemistry and on observations which system did, and which did not, form glasses, V. M. Goldschmidt stated the essential conditions for glass-forming systems as follows:

There should preferably be a tetrahedral environment for the glass-forming cations with a radius-ratio of cation and anion between 0.2 and 0.4 and the anions should be not too polarizable, e.g., should preferably be F^{-1} or O^{-2}. Beryllium fluoride BeF_2 can be considered as a "weakened model structure" of silicon dioxide, since the radius ratios are similar but the number of electrostatic bonds is halved. Consequently glasses based on BeF_2 have lower melting points and refractive indices and are more open to attack chemically than glasses and glazes based on SiO_2.

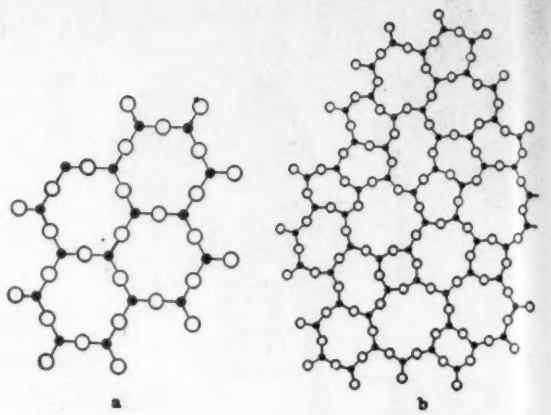

Figure 1. Schematic representation in two dimensions of the difference between a crystal and a glass. (a) crystal; (b) glass.

Zachariasen extended Goldschmidt's theory which brings out the essential similarities between crystals, glasses and glazes of similar composition. The strength and hardness of glasses and glazes at ordinary temperatures render it likely that the nature of the bonds within the solids must be of the same kind as in the corresponding crystals, i.e., electrostatic bonds held atoms which oscillate around equilibrium conditions. The lack of anisotropy observed requires that there is no three-dimensional periodicity, but a random arrangement of atoms. The fact that stable glasses and glazes occur implies that the energy of this random arrangement cannot be much larger than that of the corresponding crystals.

Based on these considerations Zachariasen set out to find what arrangements of cations and anions could be made to fit all these requirements. Selecting oxides only, and taking into consideration which oxides were known to form glasses, he arrived at the following rules for glass-forming oxides: K_mO_n. Any oxygen atom must not be linked to more than two K atoms. K must be in three-fold or four-fold co-ordination with regard to oxygen, the (KO_3 and KO_4) complexes share at least three oxygens but any given two triangles or tetrahedra can only share one oxygen.

The law established by V. M. Goldschmidt[11] is that the ratio $r_K : r_o$ has to be between 0.2 and 0.4. The list of potentially glass-forming oxides given by Zachariasen is as follows: B_2O_3, Sio_2, GeO_2, P_2O_5, As_2O_5, P_2O_3, As_2O_3, Sb_2O_3, Cb_2O_5, Ta_2O_5.

A diagrammatic picture in two dimensions of a crystalline and the corresponding glassy arrangement of atoms by Zachariasen is shown in Fig. 1. This picture gives also a good account of the different behavior upon heating of a crystal and a glass. On heating a crystal, the oscillations of the atoms around their equilibrium distances will become larger and larger until, at a given

(*Continued on page* 328)

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GLASSES AND GLAZES . . .

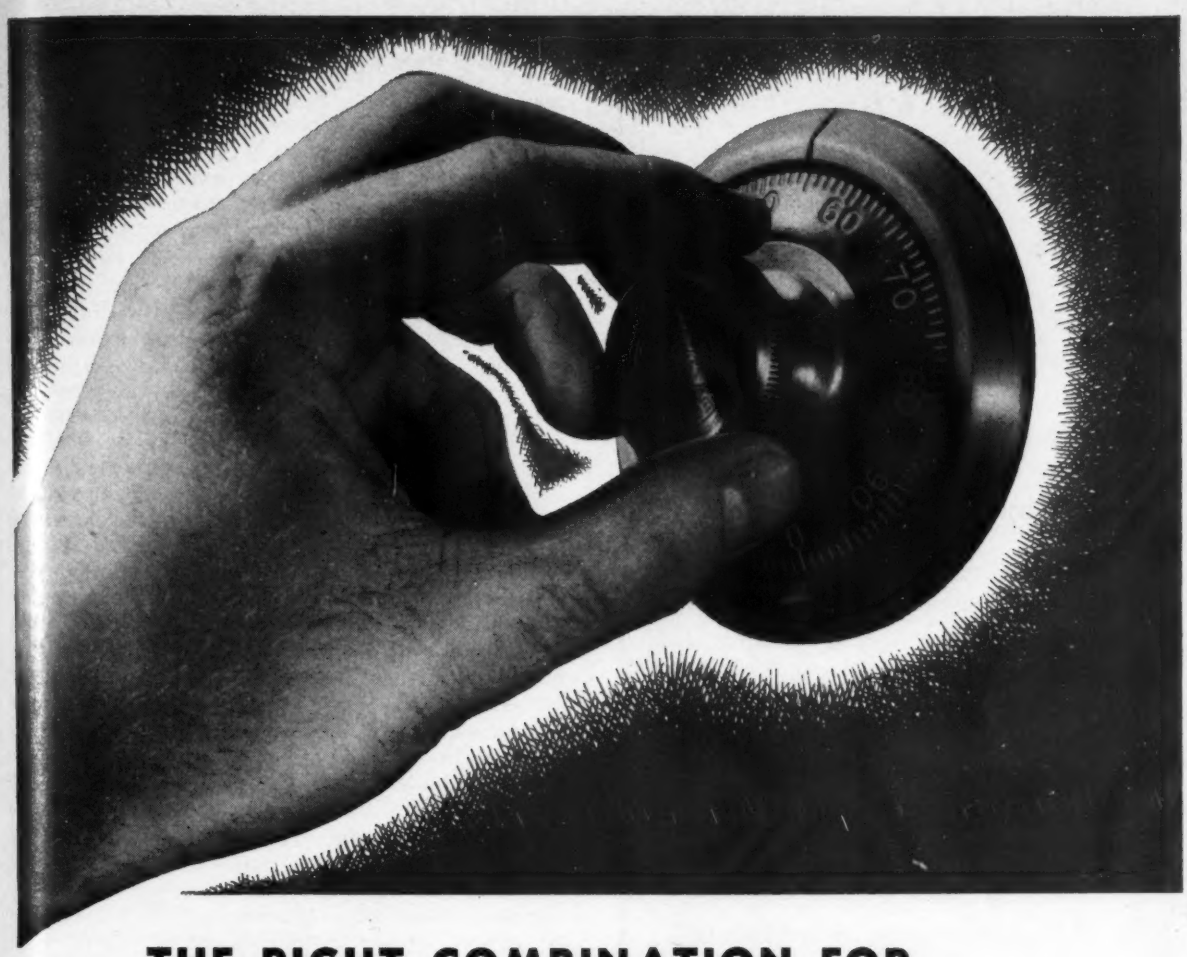
(*Continued from page* 326)

temperature, the movements become so strong as to disrupt the crystal and to cause melting. Since very many atoms are all bonded at the same strength, melting will occur suddenly a at given temperature. In a glass, on the other hand, ionic distances and bond strength are spread over an interval and instead of a sharp melting point more and more bonds will be broken as the temperature rises and there will be a softening interval instead of a melting point.

After dealing with simple oxide systems Zachariasen went on to extend his theory to oxide glasses in general. Instead of a three-dimensional network formed entirely by oxides such as B_2O_3, SiO_2, GeO_2 and so forth with the requirements described above, it is only necessary that there should be many of these oxides present in order to form the random three-dimensional network. Glasses and glazes, in general, cannot be represented by stoichiometric formulae, and the so-called "Molecular Formula for Glazes" is nothing but an agreed expediency for easier handling of the many thousands of types of different glaze groups and individual glazes. Their real representation should be expressed as the general type A_mB_nO. B here represents the highly charged small network-forming cations, and A all other cations in the glasses and glazes, which are located in the holes formed by the Fig. 1. In order to satisfy the requirement that the lattice energy is now much altered, the ionic potential of the ions A should be small, or in other words, their radius should be large and their charge low. This holds for the ions Na^{+1}, K^{+1}, Ca^{+2}, Ba^{+2}, Pb^{+2}, usually found in glass. Small and highly charged cations such as Ti^{+4} or Mg^{+2} would tend to promote devitrification.* It is now customary to refer to cations B as network-forming and to cations A as network-modifying ions. Al^{+3} occurs in four-fold co-ordination with oxygen in silicate crystals and can, in the presence of much Si^{+4}, act to some extent as a net work-forming cation in glasses and glazes. The limitations of the alumina content in glasses and glazes and the "alumina anomaly" have been mentioned above.

A statistical survey of many glasses showed Zachariasen that the numerical value of n in the formula A_mB_nO is usually around 0.4 and exceeds the value of 0.5 only in the presence of boric oxide. The requirements set out above for the trigonal or tetrahedral environment of network-forming cations and of the sharing of at least three oxygens give a range of 0.35-0.5 for tetrahedral and a maximum for trigonal glasses denoting unchallenged agreement between theory and facts. The network-modifying cations A of large radius and low charge are located in the holes formed by the random network which are pictured as lined by oxygens. Since these holes are distributed at random and do not show any strict periodicity, there is no restriction on the amount of A except that the whole glass A_mB_nO must have a balance of positive and negative charges.

*This theory is an absolute agreement with the practical experience of the ceramist and explains two of the different means of converting brilliant glazes into matt ones (devitrified glazes) by substituting for example CaO by MgO or by adding TiO_2.



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2. **It must be stable amber free from seeds and blisters.**
3. **It must be an amber color with reddish tints rather than yellow or brown.**
4. **The intensity of amber color must not vary too much from day to day or week to week.**
5. **Melting and batch cost per ton glass must be within reason. These things must be done at the lowest possible cost, which means using raw materials within the freight rate limitation of the producing plant.**

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QUALITY CONTROL . . .

(*Continued from page* 302)

may usually be seen. Sometimes the correlation is an unexpected one. For instance, when density goes out of control, look first at batch charts. If the assignable cause is not apparent here, it may lie in a temperature chart since the flow pattern may have been upset and we may be using glass from a hitherto stagnant area.

It should be pointed out that there is a lag between causative and resultant factors. This time lag is usually fairly constant for any particular glass tank. Variations in the lag time should be watched as a possible indication of trouble.

One of the most difficult and time consuming parts of the quality control technique is the selection of the proper grouping for size of sample. For example, Dr. Ghering[1] suggests a grouping of three days' samples for density measurements. Glass tanks are notoriously different in many ways and a grouping of two days or five days may be more appropriate and give more information for some tanks. It may happen that a grouping of three to five samples from different parts of the tank on the same day may show incipient changes more rapidly. No definite rules should be laid down. The grouping is the one giving best results for each case.

Finally, we should consider quality control of the many auxiliary products used in the factory. The paper and paperboard should be tested for pH water absorption. If coal is burned, the sulphur and ash contents may be controlled.

To summarize briefly, quality control methods should be applied to measurements made in a glass plant because they offer the best known method of determining that elusive factor, the assignable cause.

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DOMINION GLASS PLANS NEW GLASS MELTING FURNACE

Dominion Glass Co. plans an expenditure in excess of $1,000,000 which will provide for a new glass melting furnace equipped with the most modern container manufacturing machines and annealing equipment.

Installation of these additional production facilities will necessitate additions to the main factory buildings. Improved machine shop and mold handling facilities will also be provided. It is expected the project will be completed within approximately six months.

• The Executive Committee of the Board of Governors of the Midwest Research Institute has announced the election of Charles N. Kimble, Sc.D., to the presidency.

SURFACE COMBUSTION APPOINTS SALES ENGINEER

The appointment of Arthur H. Navarre as Sales Engineer, Glass Division, has been announced by H. C. Weller, Manager of the Ceramic Division of Surface Combustion Corporation.

A graduate of Ohio University, Mr. Navarre served in the Marine Corps for over four years, attaining the rank of First Lieutenant. He has been associated with Surface Combustion Corporation since the end of the war and has devoted his full time to engineering of furnace equipment for the glass and ceramic industries, in addition to the field operation of such equipment. He will continue to have his headquarters in the Toledo office of the firm.

PITTSBURGH CORNING DAYLIGHTING RESEARCH CENTER

The construction of an experimental classroom building has recently been completed at Port Allegany, Pa., by the Pittsburgh Corning Corporation. Designed in accordance with the newest schoolhouse construction practices, the Daylighting Research Center serves as an experimental station for the testing of glass block fenestration performance and the general development of the coordinated classroom.

Research engineers have full freedom to experiment in the new classroom. Comparison tests of various glass block patterns are easily made since certain blocks can be removed by masons within half an hour. The mortar around a block is easily chipped away, a new block put in place, and fresh mortar tamped in the joints around the new block perimeter. Such flexibility permits illuminating experts the opportunity required for detailed study of special lighting problems.

According to Mr. Nichols, the new company will produce a number of chemicals from hydrocarbons contained in the natural gas stream transported by Tennessee over its pipeline network from Texas and Louisiana fields to the northern and eastern markets.

MISSISSIPPI GLASS NAMES REPRESENTATIVE

J. N. Louttit, District Sales Manager of the Mississippi Glass Company, has announced the appointment of John D. Badgley as Southwestern sales representative.

Mr. Badgley has been assigned to the territory previously covered by Donald R. Lawson, who has resigned. Mr. Badgley will have his headquarters at St. Louis, Missouri, and will cover the states of Missouri, Kansas, Oklahoma, Arkansas, Texas, Mississippi, Louisiana, and the western portions of Tennessee and Alabama.

• Corning Glass Works has signed a contract with Cincinnati Station WLW to promote the sale of its Pyrex housewares over television for a 22-week test period beginning May 1.

PRECISION FORMED
FOR
Efficient Production

CRYSTALITE (mullite-bonded mullite) glass feeder parts are rigidly controlled through each production phase for close tolerance, dimension accuracy as well as uniform quality. Time wasting adjustments are eliminated.

For better, more efficient production . . . elect **REMMEY CRYSTALITE,** feeder parts to do the job.

BONUS-BUILDING SPOUTS
Long-lived, firm closure at tube seat . . . close-tolerance machined for uniformly accurate location in feeder.

BONUS-BUILDING TUBES
High refractoriness and erosion resistance assure enduring firm closure at tube seat . . . and thorough agitation.

BONUS-BUILDING PLUNGERS
Retain shape longer for continued, more accurate control of glass gob.

BONUS-BUILDING ORIFICE RINGS—Retain shape and size for longer runs without costly replacement shutdowns.

BONUS-BUILDING BURNER BLOCK—Accuracy of dimension for quick, hairline matching to burners.

BONUS-BUILDING CHANNELS
Uniformity, accuracy, and structural quality combine for longer productive life.

REMMEY
Dependable Refractories
RICHARD C. REMMEY SON CO.
Philadelphia 37 • Pennsylvania

G.C.M.I. MEETING . . .

(*Continued from page* 301)

The Committee's report also reviewed the work being carried on in developing a line of One-Way Carbonated Beverage Bottles, and also in the development of revised Federal Specifications for Prescription Bottles and dropper bottles and powder jars used by the Armed Services Procurement Agency.

This group's Sub-Committee on Beer Bottles, and its Sub-Committee on Milk Bottles, also reported. The former, headed by G. A. Mengle, reported the outcome of a joint meeting with the Brewers' Containers Committee of the U.S.B.F. and the Small Brewers Association, at which certain styles and sizes of bottles were approved for inclusion in the Brochure for Beer Bottles, and a resolution adopted regarding the specifications for amber color for beer bottles.

The Milk Bottle Sub-Committee, headed by R. M. Lamb, Jr., of the Lamb Glass Company, advised that nine drawings in the Milk Bottle Manual had been reissued with capping clearance dimensions changed to provide for better performance, and that the container design for the 17¾-ounce square quart bottle was improved by the addition to the drawing of more detailed contour specifications which permit a fuller use of the body diameter dimension tolerances of the container.

Highlights of the report of the Committee on Package Design and Specifications, headed by G. C. Noblit of the Brockway Glass Company, Inc., include recommendations for better styles of service cases and trays; the writing of a fiber box manual for the glass container industry, now in "mock-up" or "dummy" stage; enthusiastic acceptance of the GCMI color chart; to make available packaging information to the railroads, and the development of the GCMI Cushion Tester and a new strain gauge technique.

At the conclusion of the convention it was announced that the next Semi-Annual Meeting will be held at the Seignory Club, Quebec.

PPG TWO-MILLION-DOLLAR EXPANSION

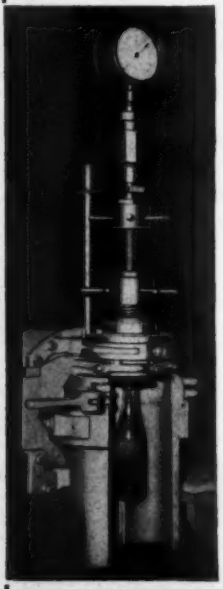
Pittsburgh Plate Glass Company will spend nearly $2,000,000 on buildings and equipment in expanding its window glass producing facilities at Mt. Vernon, Ohio. Productive capacity of the plant will be increased 50 per cent, making it the firm's largest sheet glass producer, according to Harry B. Higgins, President.

Currently a two-tank operation, the Ohio plant employs about 950 persons. An estimated 500 additional jobs will be created when the expansion program is completed.

Construction will get underway about August 1 and a third tank is scheduled to go into production within ten or twelve months after. In addition to the new tank, four glass drawing machines and other sheet glass producing equipment will be installed.

A new tank building and stack, first aid and office building, extension of existing cutting room and warehousing facilities, and expansion of nearly all other existing facilities are included in the expansion program.

MAXIMUM INDICATION GAUGE with Manual Reset Free Pointer



BOTTLES ARE HYDROSTATICALLY TESTED with this TECO

O. N. Break Type BOTTLE TESTER

Wheel to seal Bottle Gasket

Latch to Lock Safety Shield

- **BREAKING PRESSURE** is temporarily recorded by a manual reset free pointer.
- **ACCURATE TESTS** are obtained. No increment factors are involved, as with testers using weights.
- **TESTING IS SAFE** as the bottle breaks inside of a safety shield and the parts drop harmlessly into a container.
- **TESTING IS FAST** as there are no weights to handle and the required operations are simple and convenient.

UNIT FOR TESTING VARIOUS KINDS AND SIZES OF CONTAINERS

Write for Complete Descriptive Literature on TECO BOTTLE TESTER

TOLEDO ENGINEERING Company

GLASS MELTING and MANUFACTURING EQUIPMENT

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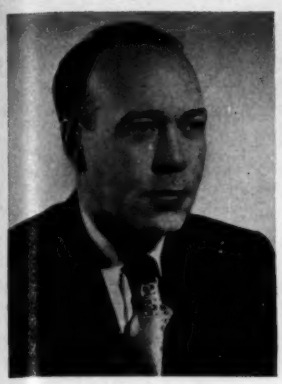


C. R. BROWN

J. W. MANTZ

DIAMOND ALKALI ANNOUNCES APPOINTMENTS

John W. Mantz, for the past two years Industrial Relations Manager at the Painesville, Ohio, plant of Diamond Alkali Company, has been promoted to the newly-created position of Assistant General Manager of the plant, according to an announcement by M. O. Kirp, General Manager.

In making this announcement, Mr. Kirp also said that C. R. Brown, who comes to the firm from National Enameling and Stamping Company, will succeed Mr. Mantz. Both appointments are effective immediately.

Mr. Mantz has been associated for 22 years in various operational capacities of increased responsibility with the Mathieson Alkali Company. In 1946, he resigned as process superintendent in charge of operations at Mathieson's Lake Charles plant to join Diamond Alkali as assistant superintendent of its Alkali Division at Painesville. Two years later he became Industrial Relations Manager, the post he now leaves in returning to plant operations as Assistant General Manager.

Mr. Brown, Mr. Mantz' successor, was associated with Sinclair Refining Company from 1934 to 1943, first as Assistant Personnel Manager and later as Personnel Manager. Following his military service with the U. S. Navy, he rejoined Sinclair, assuming full charge of the industrial relations department. In 1947, he became labor relations supervisor, leaving this post later that year to join National Enameling and Stamping Company where his duties included supervision of all industrial relations activities of five plants operated by the firm throughout the country.

COMMITTEE C-14 SUBMITS TENTATIVE STANDARD

Because an adequate standard was lacking, Committee C-14 on Glass and Glass Products of the American Society for Testing Materials has recommended that proposed Methods of Sampling and Testing Structural Non-Load-Bearing Cellular Glass Blocks (C 240-50 T) be approved as a tentative standard.

The proposal had been carefully considered by the main committee and had undergone two revisions in the subcommittee before it was submitted to the Administrative Committee on Standards.

MELTING *and* FINING

BORAX... a small addition of B_2O_3 to the glass batch, if properly substituted for a part of one or more of the major constituents, will improve the melting temperature and fining rate which should effect economies in fuel and refractory life.

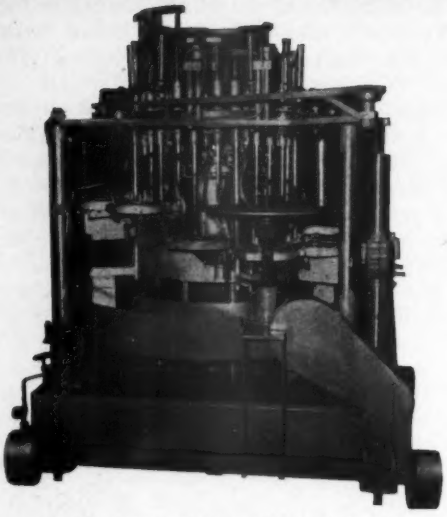
Our representatives are prepared to discuss all the special advantages of B_2O_3 in glass.

PACIFIC COAST BORAX CO.

Division of Borax Consolidated, Limited

New York • Chicago • Cleveland • Los Angeles

AUTOMATIC BURN-OFF MACHINES



AUTOMATIC HIGH SPEED OPERATION
ON LARGE OR SMALL BLOWN WARE

Write for Bulletin AB49

STEWART-GLAPAT CORPORATION
ZANESVILLE, OHIO

FIRE POLISHERS • CONTAINER FINISHERS • THE UNIVERSAL LEHR LOADER • ADJUSTOVEYOR GLASS CONVEYORS

GLASS COLORS

Uniformity and color strength developed by patient, endless research. Fifty-five years devoted to the science of Ceramic Colors.

O. HOMMEL CO.
PITTSBURGH 30, PENNA.

UNION-MANAGEMENT COOPERATION . . .

(*Continued from page* 304)

pattern originated in Ohio may be used in other areas in the country by the union for similar campaigns.

Members of our union today make many different products beside glass containers. They produce fiber glass, spun glass, glass block, television tubes, battery jars, insulators, carboys, closures, glass sand, corrugated boxes for glass plants and medical glassware.

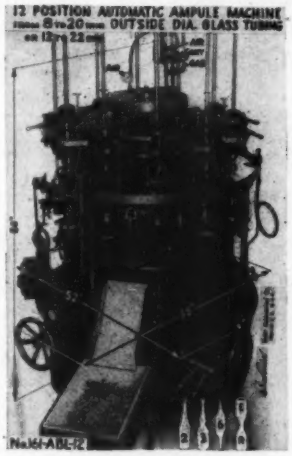
The Glass Bottle Blowers Association and its entire membership are justly proud of the contributions they have made to the advancement of labor relations in the glass container industry. The association and its members are likewise justly proud of the stability which has been created within the industry by maintaining a high level of production and by increasing the economic level of its membership. This can and will continue by the application of sincerity, honesty and understanding.

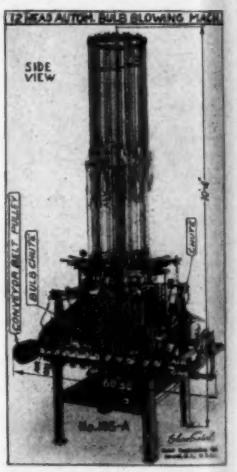
FIBERGLAS ANNOUNCES PAPER REINFORCEMENT

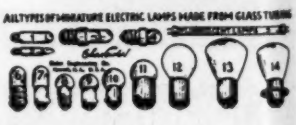
A non-woven scrim fabric of Fiberglas yarns for reinforcement of papers has been announced by Owens-Corning Fiberglas Corporation.

Bonded by an asphalt adhesive, the Fiberglas scrim fabric is placed between two sheets of Kraft paper. The two sheets and the scrim fabric are then bonded together in a sandwich construction.

EISLER
Automatic Glass Machinery
For the Manufacture
of Incandescent Lamps and All Types of Electronic Tubes







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CHAS. EISLER, Pres.
742 SOUTH 13TH STREET (near Avon Ave.) NEWARK 3, N. J., U.S.A.

PACIFIC COAST BORAX MOVES N. Y. OFFICE

The Pacific Coast Borax Company, Division of Borax Consolidated, Ltd., is moving its Eastern headquarters from their present location at 51 Madison Avenue, New York, N. Y. to new offices in the 100 Park Avenue Building which has recently been erected on the site of the old Murray Hill Hotel.

FREIGHT RATE WAR

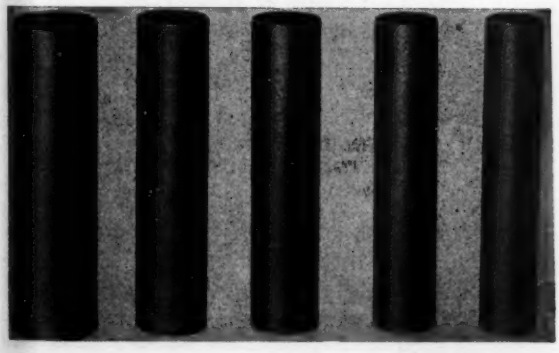
While railway freight has been subjected to rate increases with railroad rates at an average 55 per cent above those of 1946, the trucking industry has offered competition. Although truck rates have also increased, they have a more elastic rate structure and the trucks have been able to threaten the railroads for traffic in glass products.

That the ICC itself recognizes the value of truck service for special needs is seen in its approval of the application of the Nilson Motor Express of Walterboro, South Carolina, to transport containers made by the Laurens Glass Works, Laurens, South Carolina, to points in Alabama, Arkansas, Louisiana, New York and Pennsylvania.

"The shipper's customers are presently carrying small inventories and they expect the shipper to expedite the shipment of stock as needed," the commission said. "Rail service is not satisfactory because the customers desire prompt delivery, prefer to buy in small quantities, and many of them are not on railroad sidings."

The Pittsburgh Branch of the Special Libraries Association were guests of the Science and Technology Library of the University of Pittsburgh on May 18.

GUNITE



ROUND BAR STOCK

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GUNITE FOUNDRIES
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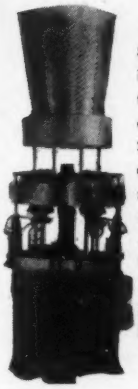
KAHLE specialists in custom built glass-making machinery

#1502
AUTOMATIC GLASS TUBING, CUTTING MACHINE — VERTICAL TYPE
For Soft Glass, Chill Cut



8 heads; indexing. Dual motor drive; variable speed. Single or (ill.) double cut-off stations. Cuts variety of diameters, lengths. Capacity: 1,000-3,000 pcs. per hour.

You can't *buy* stock equipment at Kahle. We solve *specific* problems and do a better job—because we do nothing else but *custom* machine designing and building. Whatever *your* glass manufacturing or finishing need, Kahle can give you the sound experience and foresight that has helped others operate *more efficiently*!

We're Specialists in equipment that cuts costs, increases production, assures uniformity in the manufacture of: ampules ● cathode ray tubes ● standard, miniature, sub-miniature radio tubes ● sub-miniature tubes ● fluorescent lamps ● incandescent lamps ● photocells ● x-ray tubes ● glass products.

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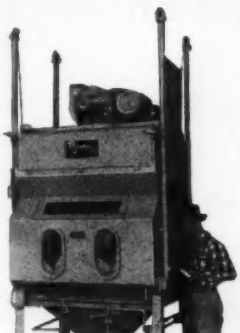
HYDRO-FINISH SAVES TIME Cleaning Glass Molds!



IF you want to clean glass molds faster—get Pangborn Hydro-Finish! With Hydro-Finish cleaning is easy and molds need little or no additional hand polishing. No pits, grooves or other imperfections are left after cleaning. Sharp edges and contours are maintained because Hydro-Finish holds tolerances to a precision .0001"!

For faster, easier, better cleaning and finishing, specify Pangborn Hydro-Finish for your plant. To get full data write for Bulletin 1400-A. Just address: PANGBORN CORPORATION, 1211 Pangborn Blvd., Hagerstown, Maryland.

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